2MO1542

HEWLETT PACKARD

Training Guide

HP E2433-60004 Training Kit for HP 1660 Series Logic Analyzers

© Copyright Hewlett-Packard Company 1992
All Rights Reserved.

Reproduction, adaption, or translation without prior written permission is prohibited, except as allowed under the copyright laws.

Warranty

The information contained in this document is subject to change without notice.

Hewlett-Packard makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability or fitness for a particular purpose.

Hewlett-Packard shall not be liable for errors contained herein or for damages in connection with the furnishing, performance, or use of this material.

This Hewlett-Packard product has a warranty against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products that prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by Hewlett-Packard.

For products returned to Hewlett-Packard for warranty service, the Buyer shall prepay shipping charges to Hewlett-Packard and Hewlett-Packard shall pay shipping charges to return the product to the Buyer. However, the Buyer shall pay all shipping charges, duties, and taxes for products returned to Hewlett-Packard from another country.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

No other warranty is expressed or implied. Hewlett-Packard specifically disclaims the implied warranties of merchantability or fitness for a particular purpose.

Exclusive Remedies

The remedies provided herein are the buyer's sole and exclusive remedies. Hewlett-Packard shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

Assistance

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales Office.

Safety

Do not install substitute parts or perform any unauthorized modification to the instrument.

WARNING

The Warning symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a Warning symbol until the indicated conditions are fully understood and met.

CAUTION

The Caution symbol calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a Caution symbol until the indicated conditions are fully understood or met.

Hewlett-Packard
P.O. Box 2197
1900 Garden of the Gods Road
Colorado Springs, CO 80901

Training Guide

Publication Number E2433-90910
First Edition, August 1992

HP E2433-60004 Training Kit for HP 1660 Series Logic Analyzers

Logic Analysis made easy: a self-paced training guide

This book and the accompanying logic analyzer training board will quickly acquaint you with the features of the HP 1660-Series Logic Analyzers. After you have completed the short exercises in this book, you will have used most of the major features of your analyzer. You will perform basic timing and state analysis measurements, and you will learn how to make more complex measurements, including how to compare two state listings, how set up complex state triggers, and how to make state and timing measurements simultaneously. You will see how easy it is to use the HP 1660-Series Logic Analyzers, and, at the same time, learn basic digital measurement concepts.

The exercises in this training guide are designed to work with any of the HP 1660-Series Logic Analyzers, with one exception: the exercise in Chapter 4, " Mixed Mode Exercises," will not work with a HP 1663A.

Materials needed

In order to do all of the exercises in this training kit, you will need:

- One HP 1660 Series Logic Analyzer
- This training kit (part number HP E2433-60004)
- Probe assembly (part number HP 01650-61608) or termination adapter (part number HP 01650-63203)

A word about the Front-Panel User's Interface

The front-panel user's interface consists of **arrow** keys (⇐, ⇑, ⇒, ⇓), the knob, the **page** keys, the MENU keys, and special keys such as **Select**, **Done** and **Run**.

The arrow keys move the white cursor around the display. Many items on the display can be activated by placing the cursor on the item and pressing the **Select** key. In many cases, this will bring up a pop-up menu from which you can make a choice. The **Done** key closes menus and text editing fields.

When you place the cursor on top of certain fields, you can continuously vary the values of the fields using the knob. You can also use the knob to scroll through data listings and waveforms, and menu choices. Like the knob, the page keys help you quickly page through data listings, waveforms, and other lists of items. The page keys let you page through only one item in each menu. You can not assign them to items the way you can assign the knob.

The six MENU keys **System**, **Config**, **Format**, **Trigger**, **List**, and **Waveform** help you move quickly through the logic analyzer set-up and display menus. The **Run** and **Stop** keys start and stop logic analyzer acquisitions.

All of the exercises in this training guide can be performed using a mouse. When an instruction tells you to highlight an item and press the **Select** key, you can simply point to that item with the mouse pointer and press the left mouse button. If you are using a mouse, some of the pop-up menus on your display will have different appearances from the figures in this guide. These pop-up menus have been designed to operate more easily with a mouse.

Configuration Disk

Your training kit includes a disk that contains configuration files for the logic analyzer. There is a file for each chapter of the training guide. The configuration files set up the analyzer so you can perform an exercise. This allows you to perform the exercises in any order. You do not need to use the configuration files to do the exercises if you are working straight through this training guide, chapter by chapter.

Getting Unexpected Results

If you get lost ,or the results of an exercise seem to be different than this guide indicates, the system may have a previously set configuration that prevents the exercise steps from working properly. To remedy this, you can recycle the power and restart the exercise, or load the configuration files for the exercises you want to do.

In this book

This book is a fast-track guide to quickly acquaint you with HP 1660 Series Logic Analyzers. You will learn how to set up the logic analyzer and quickly begin making basic measurements with confidence.

This book can be used in two ways: you can start at the beginning and progress chapter by chapter in a building block approach, or you can randomly access the exercises you want to do with minimum setup.

While you are performing the exercises, you will sometimes see the selection you want on the display, before you do a step. We purposely designed the exercises this way to make sure you would not get lost if, for any reason, the display contained a different selection. You may skip these kinds of steps if the selection you want is already displayed.

Chapters 1 through 5 contain measurement exercises designed to be completed quickly and to give you the knowledge and confidence you need to start making successful measurements in your work environment.

Chapter 6 contains the information you need to set jumpers on the Logic Analyzer training board and to load configuration files. You will only use chapter 6 occasionally.

Chapter 7 is a reference chapter describing the training board. It includes a schematic diagram of the training board circuitry.

If you need additional details on the operation of your logic analyzer, refer to the User's manuals supplied with your system.

Contents

Part 1 Exercises

1 Timing Analyzer Exercises

Starting the Exercises 13
Change a Label Name 14
Modify the Channel Assignments 15
Set the Pattern for the Trigger 16
Set Up the Trigger Sequence 17
Trigger on the Pattern and Examine the Trace 18

2 State Analyzer Exercises

Starting the Exercises 21
Configure the State Analyzer 22
Set Up the State Clock 23
Change a State Label Name 24
Modify the State Analyzer Channel Assignments 25
Define the Pattern for the State Trigger 26
Set Up Level 1 of the State Trigger Specification 27
Set Up Level 2 of the State Trigger Specification 28
Run the State Analyzer, View and Change the State Listing 29
Create a Symbol 30
Create Additional Symbols 31
Select and View Symbols 32

3 State Compare Exercises

Starting the Exercises 35
Configure the State Analyzer 36
Select the State Clock 36
Change a State Label Name and Assign Channels 36
Set the Pattern for the State Trigger 37
Set Up the State Trigger Specification 37
Run the State Analyzer and View the State Listing 38
Copy the State Listing to the Compare Reference Listing 39
Change the Jumper 40
Run the State Analyzer and Find the Errors 41

4 Mixed Mode Exercises

Starting the Exercises 45
Connect the Timing Analyzer 46
Configure the State and Timing Analyzers 47
Create a Timing Analyzer Label 48
Turn on the TCOUNT Label in the Waveform Menu 48
Clear the Timing Analyzer Trigger 48
Set Up the State Trigger Sequence 48
Enable Time Correlation between the Timing and State Analyzers 50
Arm the Timing Analyzer 51
Run the Analyzers and View the Mixed Mode Display with Time-Correlated Markers 52

5 Multilevel State Triggering

Starting the Exercises 55
Configure the State and Timing Analyzers 56
Set Up the State Analyzer Format 56
Define State Trigger Terms "a" through "d" 57
Define State Trigger Terms "e" and Range1 58
Add State Sequence Levels 59
Configure State Sequence Level 1 60
Configure State Sequence Level 2 61
Configure State Sequence Level 3 62
Configure State Sequence Level 4 63
Define a Combination Term 64
Define the Trigger Term and Check the Trigger Specification 65
Run the State Analyzer and View the Trace 66

Part 2 Logic Analyzer Training Board Reference

6 Setting the Jumpers and Loading the Configurations

Setting the Jumpers 72
To Set the Jumpers 73
Loading the Configurations 74
To Load a Configuration File 75

7 All About the Logic Analyzer Training Board

Theory of Operation 79
Power Source 79
Circuit Description 79
Jumpers 80

Part 1

1 Timing Analyzer Exercises 11
2 State Analyzer Exercises 19
3 State Compare Exercises 33
4 Mixed Mode Exercises 43
5 Multilevel State Triggering 53

Exercises

1

Timing Analyzer Exercises

Timing Analyzer Exercises

Timing analysis in its simplest form means acquiring and storing data at equal time intervals. The time interval is controlled by a clock inside the logic analyzer, just like the clock in a digitizing oscilloscope. However, there are key differences between a timing analyzer and a digitizing oscilloscope. These key differences are channel count and voltage resolution. A logic analyzer typically has a large number of channels, and it displays signals at only two voltage levels, a logic high or a logic low. A digitizing oscilloscope typically has fewer channels, but it can display signals with much finer voltage resolution.

In order to determine whether a given sample of data should be stored and displayed as a logic high or a logic low, the timing analyzer compares the data to a threshold voltage. The threshold voltage works just like the threshold voltage in logic circuits. If the voltage level of the sampled data is above the threshold, the analyzer stores a logic high (a "1"). If the voltage level of the data is below the threshold, the analyzer stores a logic low (a "0").

The exercises in this chapter will step you through the process of using the timing analyzer. They are designed to show you how easy the timing analyzer is to use. You should do these exercises in the order given since they will be similar to the logical order you will perform many of your day-to-day tasks.

In this chapter you will learn how to:

- Change label names
- Modify channel assignments
- Set a trigger pattern and trigger sequence
- Use the X-marker to read timing patterns

Starting the Exercises

1 Decide what to do next.

If you have just completed "Ready, Set, Run" on the fold-out cover, go to "Change a Label Name" on the next page.

If you have not just completed "Ready, Set, Run" go to step 2.

2 Turn off the logic analyzer by pressing the power switch. Wait at least five seconds, then press the power switch again to turn on the logic analyzer.

Cycling the power defaults all system settings. This sets up the analyzer so you can perform the remaining exercises.

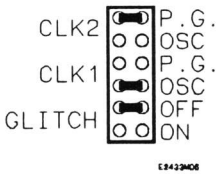
3 Connect Pod 1.

Connect Pod 1 of the HP 1660A to J1 on the Logic Analyzer Training Board. Pod 1 is the top cable in the left-most position when you are facing the rear of the logic analyzer.

4 Set the jumpers as shown below.

The jumper settings of J5 on the training board for this chapter are the same as the default settings.

Figure 1



See Also

"To Set the Jumpers" in chapter 6 for more information about setting the jumpers.

Change a Label Name

The training board has an 8-bit ripple counter that counts from 0 to 255 and then starts counting again at 0, in a repeating cycle. In the following exercises, you will set up the logic analyzer to monitor the eight channels of the counter.

1 **Press the Format MENU key to display the logic analyzer Format Menu.**

The Format Menu shows you a list of labels along the left side of the display. The fields to the right of each label show you the channels of the data pods. Labels help you to identify groups of channels. For example, you could use the label name DATA for all of the channels that you connect to the data bus of a microprocessor. In this exercise you will change the default label name, Lab1, to TCOUNT, which represents *timing count*.

2 **Use the arrow keys (⇑ ⇓⇐ ⇒) to move the cursor and highlight the Lab1 field, under Labels.**

3 **Type TCOUNT using the keypad on the logic analyzer front panel.**

You can use the knob or the left and right arrow keys to backspace the cursor if you need to correct a typing error.

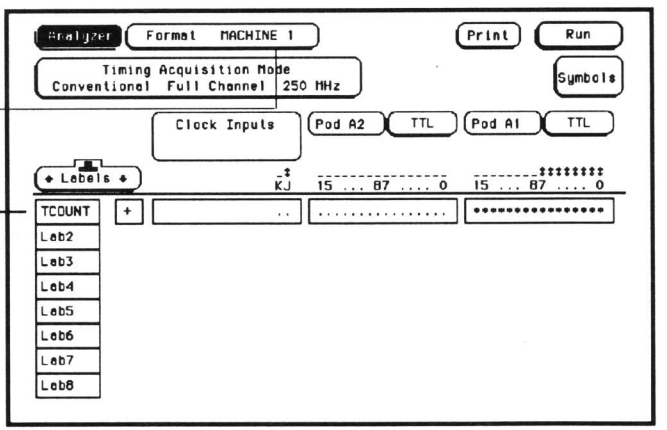
4 **Press the Done key when you are finished typing.**

Your Format menu will look like figure 2, below. If it does not, repeat this exercise.

Figure 2

Press the Format MENU key to display the Format Menu.

Use the arrow keys to highlight Lab1. Use the keypad to type TCOUNT.



Changing a Label Name

Modify the Channel Assignments

Assigning channels means grouping specific channels together within a label. In this exercise, you will assign the lower eight channels of Pod A1 to the label TCOUNT. To assign a channel to a label, you place an asterisk in its channel position.

1 Using the **arrow** keys, highlight the field showing the 16 channels of Pod A1, to the right of the TCOUNT label. Press the **Select** key.

A pop-up showing the channel assignments appears.

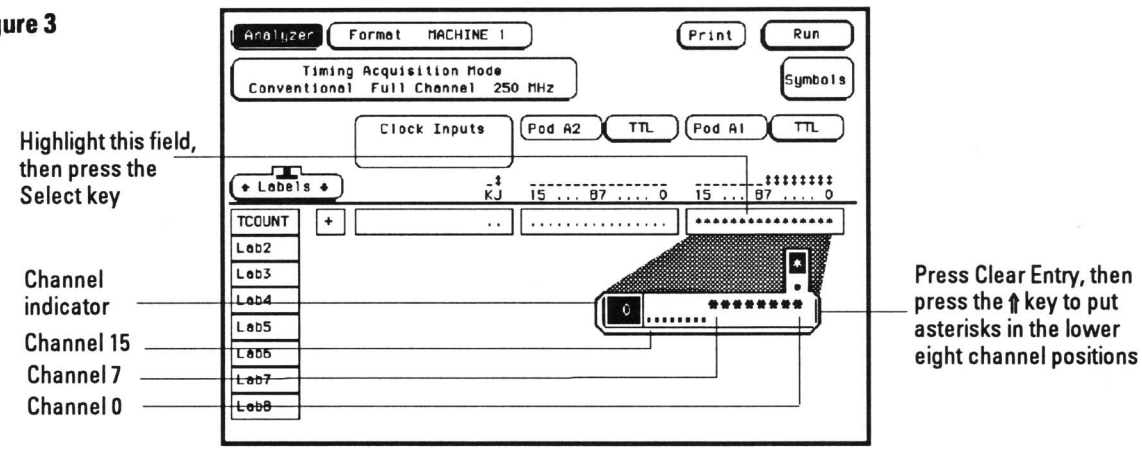
2 Press the **Clear Entry** key to clear the default bit assignments.

3 Use the knob to move the cursor to channel 7 in the pop-up. Then, press the ⇑ (up-arrow) key to put asterisks in the lower eight channel positions. If you need help, refer to figure 3, below.

The channel position indicator, at the left side of the pop-up, shows you which channel the cursor is currently on. Channels are numbered 15 through 0 from left to right.

4 Press the **Done** key to close the pop-up.

Figure 3



Modifying Channel Assignments

Set the Pattern for the Trigger

In order for the timing analyzer to store the data you want, you need to tell it when to trigger. In the Ready, Set, Run exercise, the analyzer triggered immediately. In this exercise, you will set up the analyzer to trigger when the counter on the training board reaches its maximum value of 255, or FF (hex). To do this, you will set up the Trigger Menu so that the timing analyzer triggers when the pattern FF (hex) is present for more than 16 ns. The first step is to set a trigger term, or variable, equal to the pattern "FF." You will then use the term to define the trigger condition.

1 Press the **Trigger** MENU key.

The Trigger Menu is displayed. Notice that the TCOUNT label also appears in this menu.

2 Use the **arrow** keys to highlight the base field to the right of the **Terms** field, then press the **Select** key.

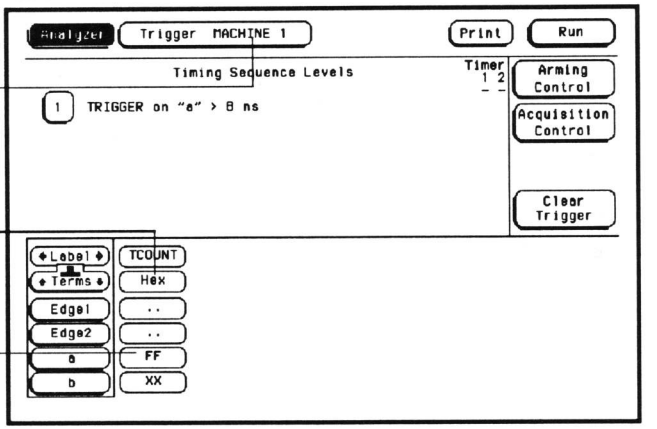
3 Use the knob to highlight **Hex** in the pop-up. Press the **Done** key.

The base field may have already displayed **Hex**, before you performed this step. The exercises are designed to make sure you would not get lost if, for any reason, the field contained a different selection.

4 Highlight the term value field to the right of the term **a**, then enter FF. Press the **Done** key.

The "a" field is a term, or variable, that you can assign values to. There are ten pattern terms, like "a", available, as well as several other terms that you will learn more about later.

Figure 4



Setting the Pattern for the Trigger

Set Up the Trigger Sequence

In this exercise, you will use the pattern term that you just defined in a trigger sequence, which tells the logic analyzer when to trigger.

1 Highlight the **1** field in the Timing Sequence Levels box. Press the **Select** key.

The Sequence Level 1 pop-up appears.

2 Highlight the field to the right of **Trigger On**. Press the **Select** key.

A pop-up menu appears, showing you the trigger terms that you can choose from.

3 Highlight **a**, then press the **Done** key.

4 Highlight the field to the right of **>**. Turn the knob to select 16 ns for the pattern duration.

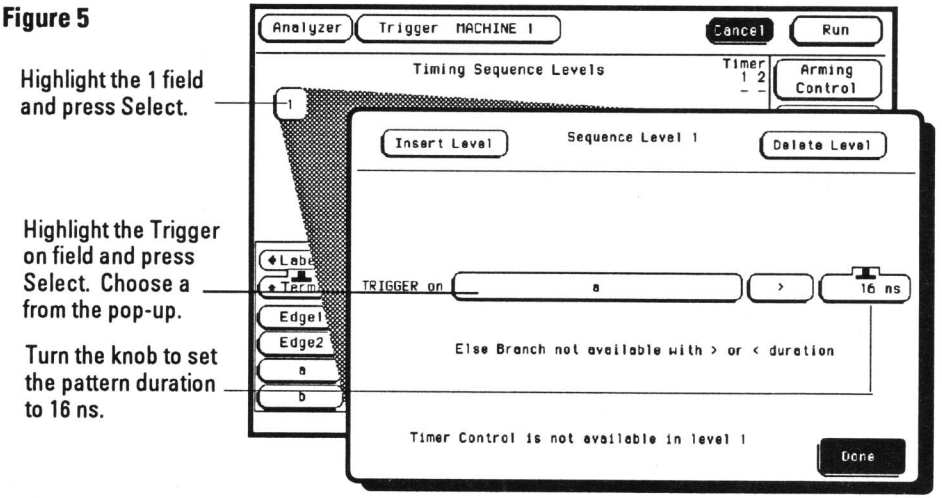
The duration is set to 16 ns so that the logic analyzer will trigger when the counter on the training board is in a stable state. A shorter duration might cause the analyzer to trigger when the counter is transitioning.

5 Press the **Done** key to close the Sequence Level 1 pop-up.

Your trigger sequence now shows :

Level 1 - TRIGGER on "a" > 16 ns

Figure 5



Setting Up the Trigger Sequence

Trigger on the Pattern and Examine the Trace

1 Press the **Run** key.

The display automatically switches to the Waveform menu and the sec/Div field is highlighted in light gray. When a field is highlighted in light gray, you can vary its value with the knob.

2 Turn the knob counterclockwise to zoom out and display more of the data.

3 Use the **arrow** keys to highlight the **Delay** field, then turn the knob in either direction to scroll through the data.

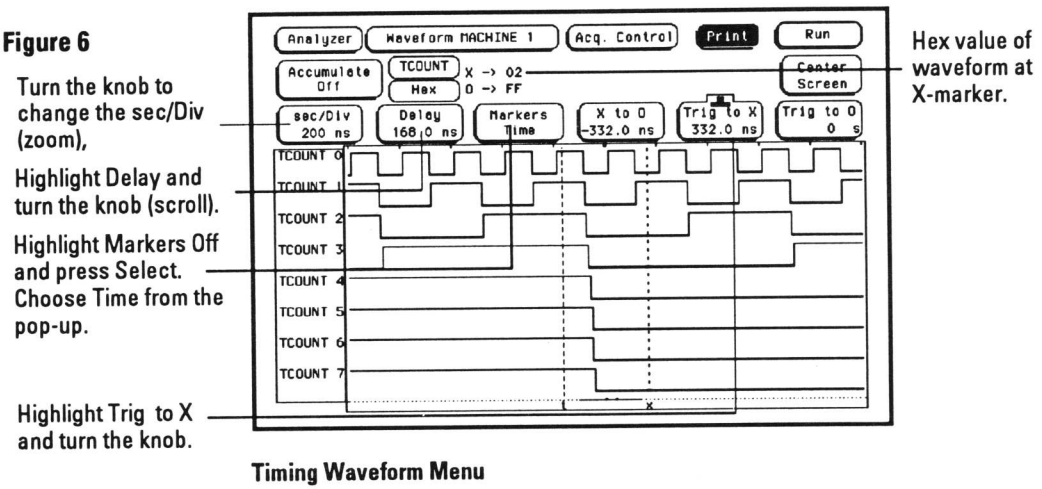
4 Highlight the **Markers Off** field, then press the **Select** key. Use the knob or the **arrow** keys to highlight **Time** in the pop-up. Press the **Done** key.

The X and O markers show you the value of the waveforms at particular points in time.

5 Highlight the **Trig to X** field, then turn the knob.

Turning the knob moves the X-marker. Note the hex value to the right of **X->**, below the **Waveform MACHINE 1** field. As you move the X-marker past transitions on the waveform, the hex value to the right of **X->** changes, showing you the value of the TCOUNT label at the current X-marker position. This makes it easier to observe the logic state of your system under test.

Figure 6



Timing Waveform Menu

2

State Analyzer Exercises

State Analyzer Exercises

State analysis in its simplest form means acquiring data and storing it when it is valid for a system under test. The differences between a state analyzer and a timing analyzer are the source of the sample clock and the way the data is displayed. In order to make sure the data is valid, the clock that controls when the state analyzer samples data is supplied by the system under test. Each time the logic analyzer receives a state clock pulse, it samples and stores the logic state of the system under test. The stored data consists of logic highs and lows (1s or 0s). Just as in the timing analyzer, the state analyzer compares sampled data to a threshold voltage to determine whether it should be stored and displayed as a logic high or a logic low. The state analyzer displays the data as a sequential listing of logical states.

What makes the state analyzer more than just a data acquisition instrument is its capability to acquire and store only the data that you specify. This is called data qualification. Examples of storing qualified data include storing only a certain subroutine in a program, storing all data being sent to a specified address in a system, or storing only data leading up to a system failure.

These exercises will step you through the process of using the state analyzer. They are designed to show you how easy the state analyzer is to use. You should do these exercises in the order given because they will be similar to the logical order you will perform many of your day-to-day tasks.

In this chapter you will learn how to:

- Configure the state analyzer
- Set up the state clock
- Change a state label name
- Modify the state analyzer channel assignments
- Set the pattern for the state trigger
- Set up the trigger specification

- Run the state analyzer, view and change the state listing
- Define and view symbols

Starting the Exercises

1 Decide what to do next.

If you have just completed the exercises in chapter 1, go to "Configure the State Analyzer" on the next page.

If you have not just completed the exercises in chapter 1, go to step 2.

2 Load the configuration files, CH02.__ and CH02._A.

The files default all system settings and set up the analyzer as if you had just completed the exercises in chapter 1.

If you are using an HP 1661A, HP 1662A, or HP1663A, you may see an advisory message when you load the files. This is not an error. The message is displayed because these logic analyzers have a different number of data pods from the HP 1660A, which was used to create the files.

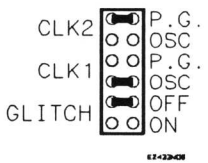
3 Connect Pod 1.

Connect Pod 1 of the Logic analyzer to J1 on the training board. Pod 1 is the top cable in the left-most position when you are facing the rear of the logic analyzer.

4 Set the jumpers as shown below.

The jumper settings of J5 on the training board for this chapter are the same as the default settings.

Figure 7



See Also

"To Load a Configuration" in chapter 6 for instructions to load the configuration files.

"To Set the Jumpers" in chapter 6 for more information about setting the jumpers.

Configure the State Analyzer

1 Press the **Config** MENU key to display the Configuration Menu.

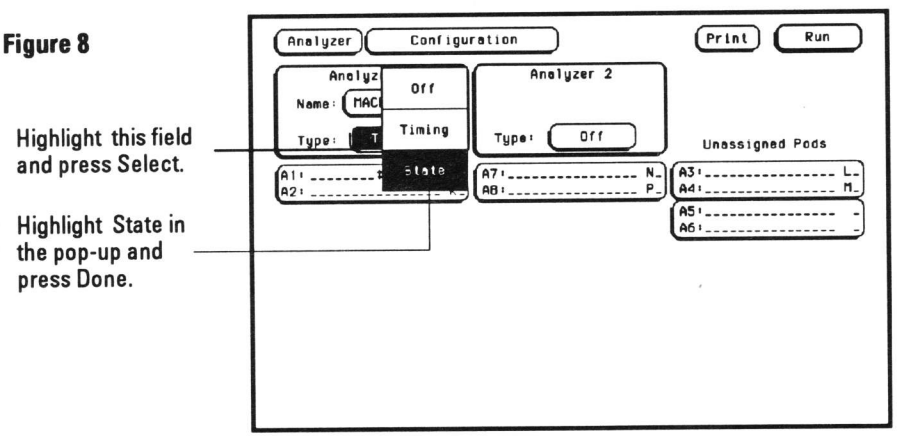
2 Use the **arrow** keys (⇐ ⇑ ⇓ ⇒) to highlight the field to the right of **Type** in the Analyzer 1 box. Press the **Select** key.

3 Use the knob or **arrow** keys to highlight **State** in the pop-up menu. Press the **Done** key.

All of the exercises in this guide were created with an HP 1660A, which has eight data pods. If your analyzer is an HP 1661A, HP 1662A, or HP 1663A, your Configuration Menu will look different than the one shown below because your analyzer has fewer than eight data pods. Each pod on the logic analyzer has 16 data channels and one clock channel.

Note the dashed lines and vertical arrows in the pod A1/A2 field. These are activity indicators that show you the signal activity on each channel. In this exercise, pod A1 has arrows on the lower eight channels and the J-clock channel, indicating that transitions across the threshold voltage are occurring on these channels. When a dash is showing at the bottom of an indicator field, it indicates that the channel is a logic low. If your logic threshold is set above 0 V, a dash at the bottom of the indicator field may mean that a channel is not connected. A dash at the top of the field indicates the channel is connected to a logic high.

Figure 8



Configuring the State Analyzer

Set Up the State Clock

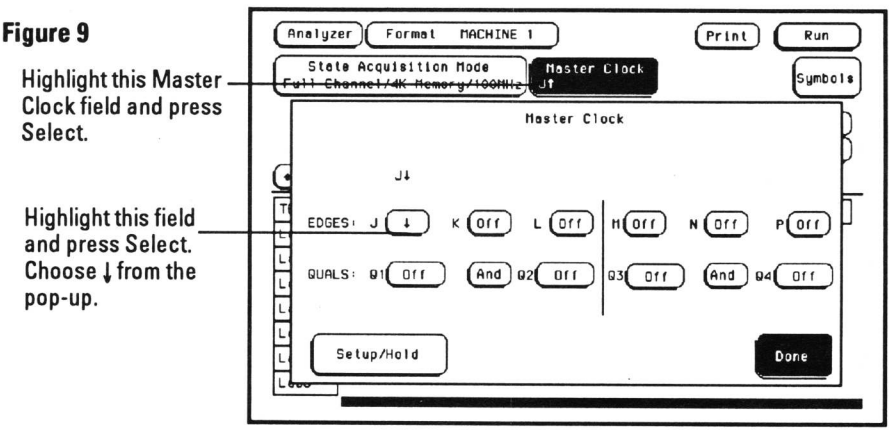
1. Press the **Format** MENU key.
2. Use the **arrow** keys to highlight the **Master Clock** field in the upper center of the display, then press the **Select** key.

   Your display will look different from the one shown in the figure below if you are using an HP 1661A, HP 1662A, or HP 1663A. There are fewer clock lines available on these analyzers than on an HP 1660A, which was used to create the figure.
3. Highlight the **J** field, then press the **Select** key. Choose ↓ (down arrow) from the pop-up menu.
4. Press the **Done** key to close the Master Clock pop-up.

   The state clock is a signal from the system under test that clocks the logic analyzer, causing it to sample and store data. Each pod, except pods A5 and A6, has a state clock channel (clocks J, K, L, and M on pods A1 through A4, respectively, and clocks N and M on pods A7 and A8). For this exercise, you are using the J-clock because pod 1 is connected to the training board and it is assigned to the state analyzer. The J-clock line is connected to the oscillator on the training board.

   The down arrow represents a negative edge. The negative edge of the clock is used to get the best results from the training board.

Figure 9



Setting Up the State Clock

Change a State Label Name

1 Highlight the **Lab2** field, below the **Labels** field.

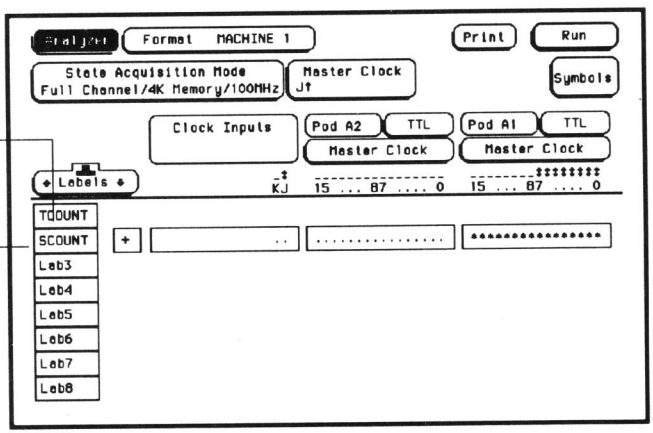
2 Type SCOUNT using the keypad on the logic analyzer front panel. Press the **Done** key when you are finished typing.

In order to keep track of the counter output when it is acquired by the state analyzer, you have named a label SCOUNT for the state analyzer exercises.

3 Highlight the top field below **Labels**, then press the **Select** key. Choose **Turn Label Off** from the pop-up.

If you have already performed the Timing Analyzer Exercise in Chapter 1, this field will be the TCOUNT label. Turning the label off now saves it for later use.

Figure 10



Changing a State Label Name

See Also

"Change a Label Name" on page 14 for a detailed explanation of label names

Modify the State Analyzer Channel Assignments

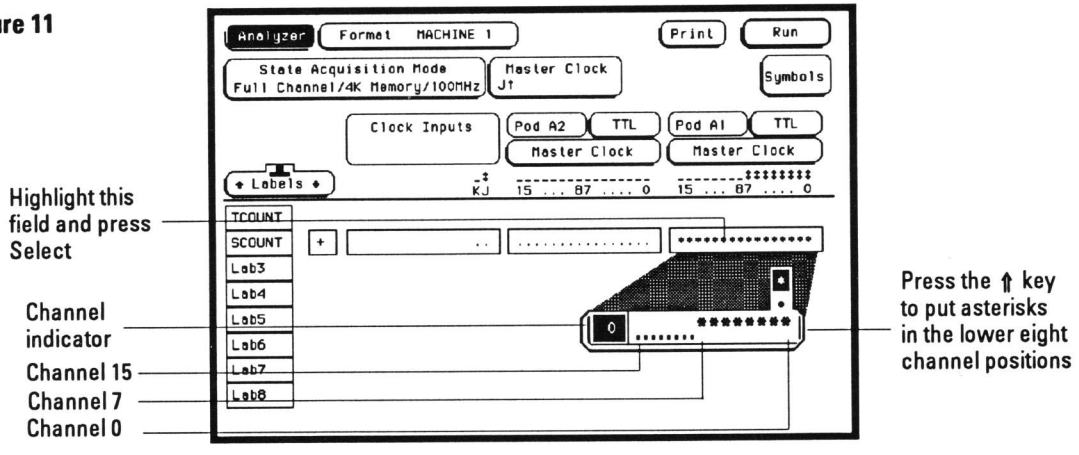
1 Highlight the field showing the 16 channels of Pod A1, to the right of the SCOUNT label, then press the **Select** key. A pop-up showing the channel assignments appears.

2 Using the knob, move the cursor to channel 7 in the pop-up. Then, press the ⇑ (up-arrow) key to put asterisks in the lower eight channel positions. Press the **Done** key to close the channel assignment pop-up.

The channel indicator, on the left side of the pop-up shows you which channel the cursor is currently on. Channels are numbered 15 through 0 from left to right.

Since you are now using pod 1 for the state analyzer, you have assigned the lower eight channels of pod 1 to the label SCOUNT.

Figure 11



Modifying the Channel Assignments

See Also

"Modify the Channel Assignments" on page 15 for a detailed explanation of channel assignments

Define the Pattern for the State Trigger

1 Press the **Trigger** MENU key.

2 Highlight the base field under the SCOUNT label, then press the **Select** key.

3 Use the knob or the **arrow** keys to highlight **Hex** in the pop-up, then press the **Select** key to choose **Hex.**

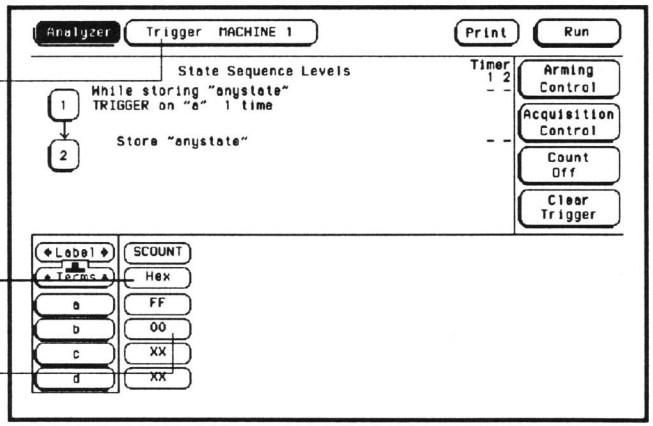
The base field may have already displayed **Hex**, before you performed this step. The exercises are designed to make sure you would not get lost if, for any reason, the field contained a different selection.

4 Highlight the field to the right of **b.**

The "b" field is a term, or variable, to which you can assign a pattern . In this exercise, you will set term "b" to a value of 00 (hex).

5 Enter 00 using the keypad on the logic analyzer front panel. Press the **Done** key when you are finished typing.

Figure 12



Defining the Pattern for the State Trigger

Set Up Level 1 of the State Trigger Specification

In the next two exercises, you will set up the sequence of events that you want the logic analyzer to follow when triggering and storing data.

1 Highlight the **1** field in the State Sequence Levels box of the Trigger menu. Press the **Select** key.

The Sequence Level 1 pop-up appears.

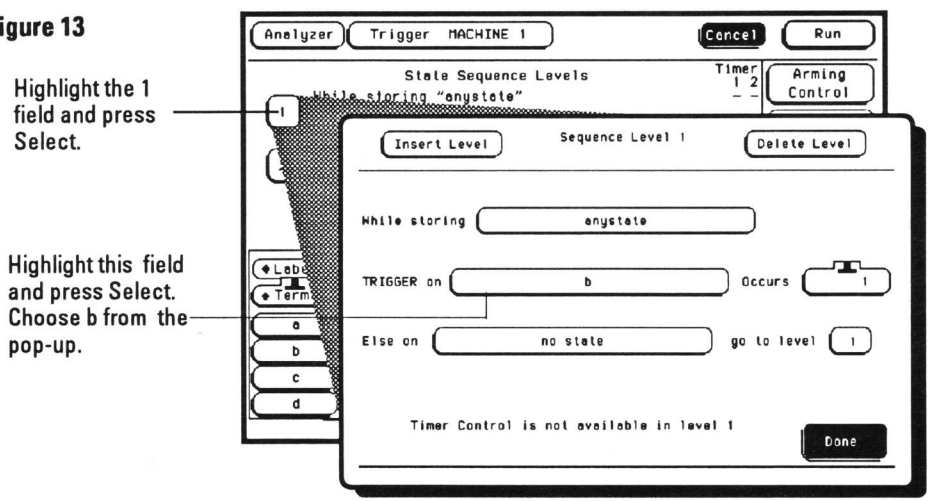
2 Highlight the field to the right of **Trigger on**, then press the **Select** key. Choose **b** from the pop-up.

The **While storing** field is set to **anystate**. This means that the logic analyzer will store any data that it samples before it finds the trigger pattern. In later exercises, you will use the "while storing" function to store only the states that you specify.

3 Press the **Done** key to close the Sequence Level 1 pop-up.

The state analyzer stores any state, starting when you touch run and until 00 is found. The state analyzer will then trigger, which causes it to fill the remaining acquisition memory.

Figure 13



Setting Up Level 1 of the State Trigger Specification

Set Up Level 2 of the State Trigger Specification

1 Highlight the **2** field in the State Sequence Levels box of the Trigger menu. Press the **Select** key.

2 Highlight the field to the right of **Store**, then Press the **Select** Key. Choose **anystate** from the pop-up.

After the analyzer triggers, it will store any data that it samples.

3 Press the **Done** key to close the Sequence Level 2 pop-up.

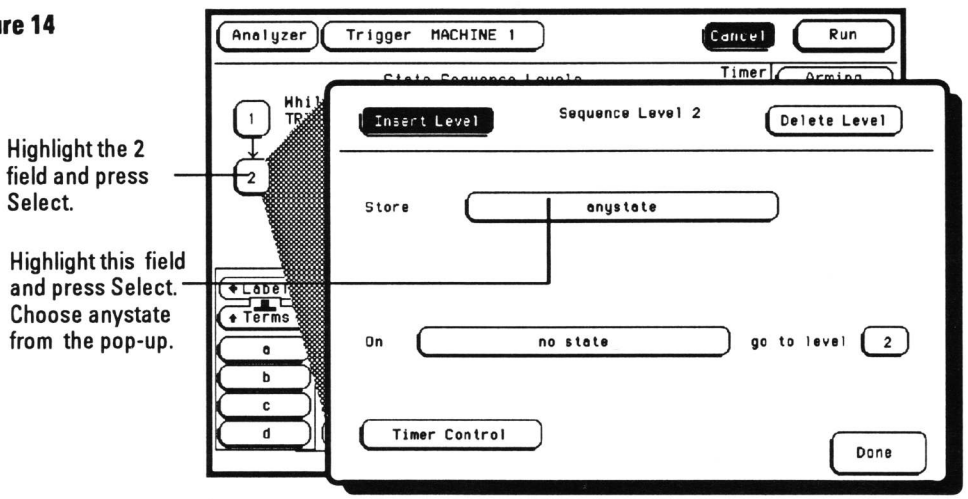
The State Trigger Specification is now:

Level 1 - While storing anystate, TRIGGER on "b" 1 time

Level 2 - Store "anystate"

If your trigger specification does not match this one, repeat the exercises, starting with "Modify the State Analyzer Channel Assignments," on page 25.

Figure 14



Setting Up Level 2 of the State Trigger Specification

Run the State Analyzer, View and Change the State Listing

1 Press the **Run** key.

The display automatically changes to the State Listing.

2 Observe the State Listing is now displaying the output of the ripple counter in hexadecimal with 00 centered vertically in the listing under the label **SCOUNT**.

There are two columns in this state listing. The left column shows line numbers which correspond to the locations of the data in the logic analyzer's memory. The right column is the state data that you just acquired from the ripple counter.

The trigger pattern 00 is centered and to the right of a light gray line number field, in which 0 is displayed. The zero line number corresponds to the trigger point you specified in the Trigger menu. The negative line numbers indicate the states stored prior to the trigger point.

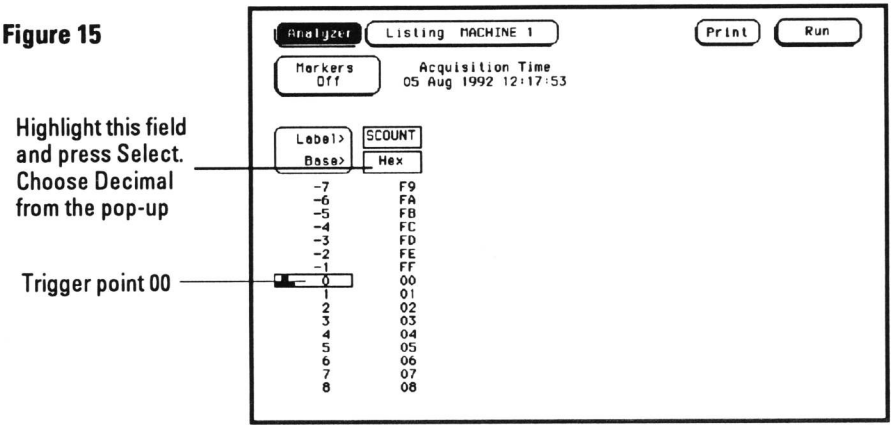
3 Highlight the **Hex** field directly below the SCOUNT label, then press the **Select** key. Choose **Decimal** from the pop-up menu.

The state listing is now displayed in decimal instead of hex.

4 Highlight the line number field, at the center of the left side of the display. Turn the knob to scroll through the state listing.

5 Press the **Page** keys, below the knob, to page through the state listing one screen at a time.

Figure 15



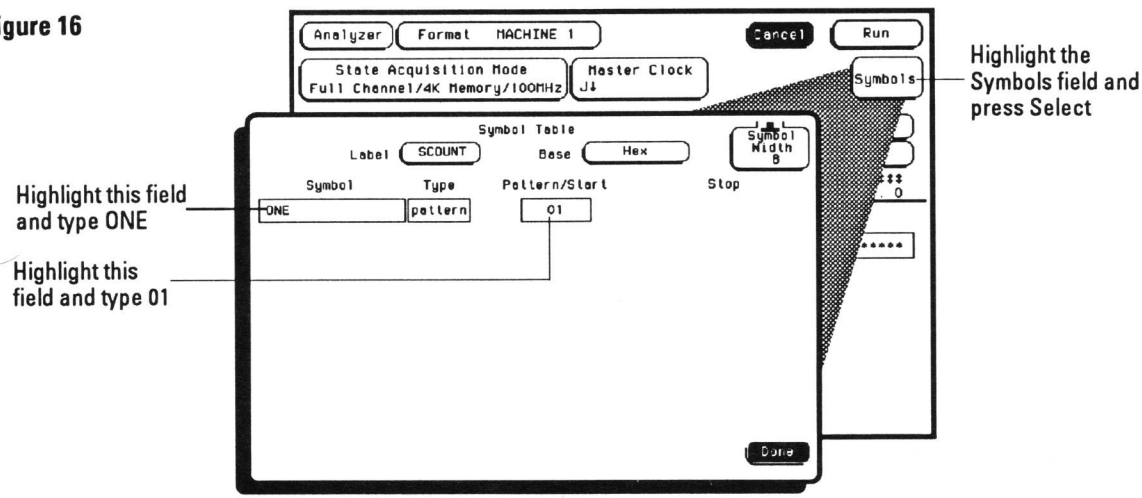
State Listing Menu

Create a Symbol

Symbols are used to display state data in easily understandable terms, which you define. This can make the state listing much easier to interpret. In the following exercises, you will define and display some symbols.

1. Press the **Format** MENU key.
2. Highlight the **Symbols** field, then press the **Select** key.
3. Highlight the **New Symbol** field near the top-left corner of the pop-up. Type "ONE" using the keypad. Press the **Done** key when you are finished typing.
4. Highlight the field below **Pattern/Start**. Enter 01 using the keypad. Press the **Done** key when you are finished typing.

Figure 16



Creating a Symbol

Create Additional Symbols

1 If the **Symbol Table** pop-up menu is now displayed, go to step 2. If this is not the case, highlight the **Symbols** field in the Format Menu. Then, press the **Select** key.

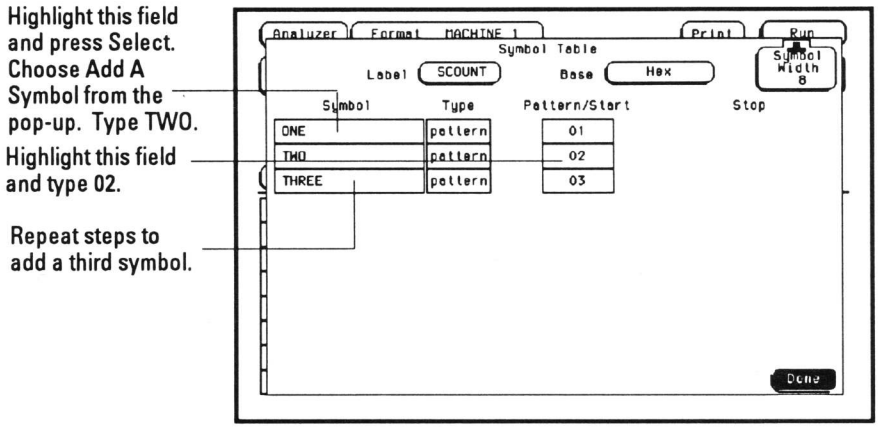
2 Highlight the **ONE** field below Symbol, then press the **Select** key. Choose **Add a Symbol** from the pop-up. Type TWO using the keypad. Press the **Done** key when you are finished typing.

3 Highlight the field to the right of the **TWO** under **Pattern/Start**. Enter 02 using the keypad. Press the **Done** key when you are finished typing.

4 Highlight the **TWO** field. Repeat steps 2 and 3 to create a symbol, THREE, with a pattern value of 03.

5 Press the **Done** key to close the Symbol Table pop-up menu.

Figure 17



Creating Additional Symbols

Select and View Symbols

1 Press the **List** MENU key.

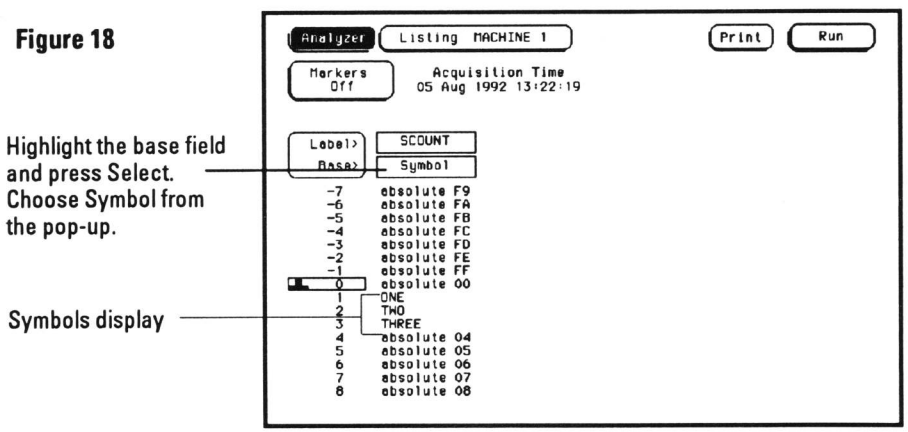
2 Highlight the base field under the SCOUNT label, then press the **Select** key. Choose **Symbol** from the pop-up. The symbols ONE, TWO, and THREE are displayed in the state listing in place of the numeric counts 01, 02, and 03, respectively.

Symbols are helpful when viewing more complex state listings. For example, you might monitor a microprocessor's status lines which have specific patterns for read and write cycles. You can define symbols for these patterns. Then, wherever a read or write cycle occurs in the state listing, you will see "READ" or "WRITE," instead of a numerical representation of the patterns.

3 Highlight the **Symbol** field under SCOUNT label, then press the **Select** key. Choose **Hex** from the pop-up.

Step 3 changes the base from decimal to hexadecimal for the rest of the exercises in this guide.

Figure 18



State Listing with Symbols

3

State Compare Exercises

State Compare Exercises

The State Compare feature allows you to compare two state listings. You can use this feature in a test environment where you want to check to make sure your system is executing correct states. You can acquire a state listing from the system under test and compare it to a listing that is known to be good. If there are errors, the Difference Listing will show you where they occur.

These exercises will step you through the process of using the Compare mode of the state analyzer. They are designed to use many of the same exercises as the State Analyzer Exercises in the previous chapter; therefore, the beginning exercises do not include figures. If you need a visual reminder on any of these common exercises, refer back to the same exercise in chapter 2, "State Analyzer Exercises."

In this chapter you will:

- Configure the state analyzer
- Select the state clock
- Change a state label names and assign channels
- Set the pattern for the state trigger
- Set up the state trigger specification
- Run the state analyzer and view the state listing
- Copy the state listing to the compare reference listing
- Change the jumper on the training board
- Rerun the state analyzer and find the errors

Starting the Exercises

1 **Decide what to do next.**

If you have just completed the exercises in chapters 1 and 2, go to "Set Up the State Trigger Specification" on page 37.

If you have not just completed the exercises in chapters 1 and 2, go to step 2.

2 **Load the configuration files CH03.__ and CH03._A.**

The files default all system settings and set up the analyzer as if you had just completed the exercises in chapters 1 and 2.

If you are using an HP 1661A, HP 1662A, or HP1663A, you may see an advisory message when you load the files. This is not an error. The message is displayed because these logic analyzers have a different number of data pods from the HP 1660A, which was used to create the files.

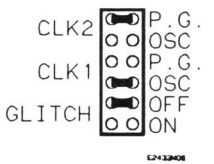
3 **Connect Pod 1.**

Connect Pod 1 of the logic analyzer to J1 on the training board. Pod 1 is the top cable in the left-most position when you are facing the rear of the logic analyzer.

4 **Set the jumpers as shown below.**

The jumper settings of J5 on the training board for this chapter are the same as the default settings.

Figure 19



See Also

"To Load a Configuration" in chapter 6 for instructions to load the configuration files.

"To Set the Jumpers" in chapter 6 for more information about setting the jumpers.

Configure the State Analyzer

1 Press the **Config** MENU key.
2 Highlight the field to the right of **Type** in the Analyzer 1 box, then press the **Select** key. Choose **State** from the pop-up menu.

Select the State Clock

1 Press the **Format** MENU key.
2 If the **Master Clock** field, direcly below the **Format MACHINE 1** field, is displaying **J** ↓, go to "Change a State Label Name and Assign Channels" below.
3 Highlight the **Master Clock** field directly below the **Format MACHINE 1** field. Press the **Select** key.
4 Highlight the **J** field, then press the **Select** key. Choose ↓ (falling edge) from the pop-up.
5 Press the **Done** key to close the Master Clock pop-up.

Change a State Label Name and Assign Channels

1 If the **SCOUNT** label appears below the **Labels** field with the lower eight channels of Pod A1 assigned to it, go to the next page.
2 Highlight the second field from the top, below **Labels**. Type SCOUNT using the keypad. Press the **Done** key when you are finished typing.
3 Highlight the field showing the 16 channels of Pod A1 to the right of the SCOUNT label. Press the **Select** key.
4 Using the knob, move the cursor to channel 7 in the pop-up. Press the ⇑ (up arrow) key eight times, to put asterisks in the lower eight channel positions. Press the **Done** key

See Also

"Set Up the State Clock" on page 23, "Change a State Label Name" on page 24, and "Modify the State Analyzer Channel Assignments" on page 25.

Set the Pattern for the State Trigger

1 Press the **Trigger** MENU key.
2 Highlight the field to the right of **a**, below the SCOUNT label.
3 Enter FF using the keypad on the logic analyzer's front panel. Press the **Done** key.

Set Up the State Trigger Specification

Start here if you just completed chapter 2

1 If the Trigger Menu is not already displayed, press the **Trigger** MENU key.

2 Highlight the **1** field in the State Sequence Levels box, then press the **Select** key. The Sequence Level 1 pop-up appears
3 Highlight the field to the right of **While storing**, then press the **Select** key. Choose **no state** from the pop-up.

Because the number of states stored before the trigger point (prestore) will vary from one acquisition to another, the State Compare function will always identify some portion of the pretrigger data as different from the original data. To eliminate this, you have set up the analyzer to store "no state" before the trigger.

4 Highlight the field to the right of **Trigger on**, then press the **Select** key. Choose **a** from the pop-up. Press the **Done** key to close the Sequence Level 1 pop-up.
5 Highlight the **2** field in the State Sequence Levels box, then press the **Select** key.
6 Highlight the field to the right of **Store**, then press the **Select** key. Choose **anystate** from the pop-up. Press the **Done** key to close the Sequence Level 2 pop-up.

The trigger specification is now;

- Level 1 - While storing "no state", trigger on "a" one time
- Level 2 - Store "any state"

If your trigger specification is not correct, repeat the exercises, starting with "Configure the State Analyzer" on page 36.

Run the State Analyzer and View the State Listing

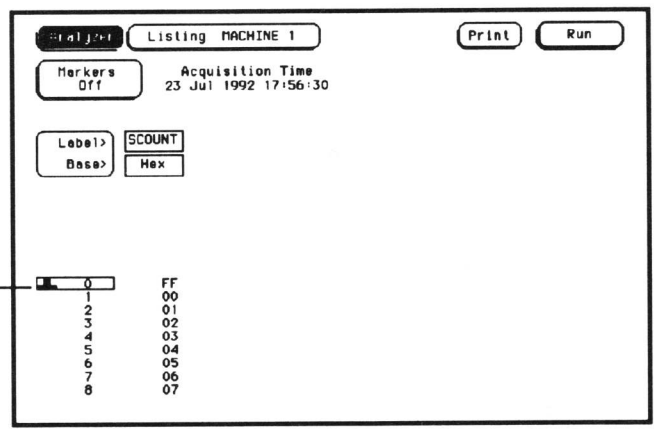
1 Press the **Run** key.

The display automatically changes to the State Listing.

2 The State Listing is now displaying the output of the ripple counter in hexadecimal with FF (hex) at the top of the listing under the SCOUNT label.

When the listing appears, FF is at the beginning of the listing and to the right of a field in which 0 is displayed. The zero line number always displays the trigger point specified in the Trigger menu. There are no negative line numbers preceding the trigger point because the pretrigger specification was set to "While storing no state."

Figure 20



State Listing

Copy the State Listing to the Compare Reference Listing

1 Press the **List** MENU key, then choose **Compare** from the pop-up.

2 Highlight the **Copy Listing to Reference** field, then press the **Select** key.

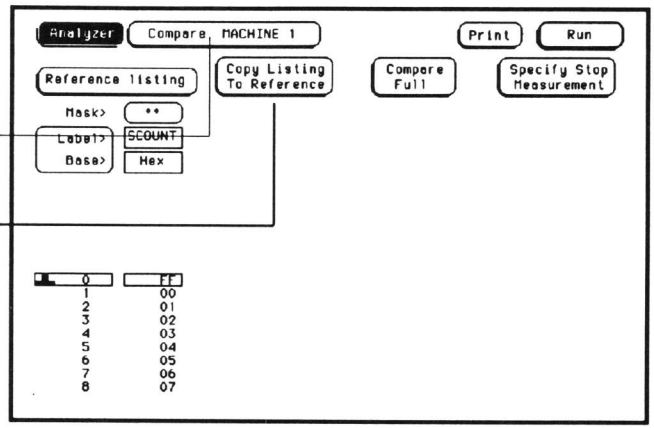
3 Highlight the **Execute** field in the pop-up, then press the **Select** key.

The state listing acquired in the previous exercise is now stored as the reference listing to which other state listings can be compared. This feature can be used in a test environment where you want to check to make sure your system is executing correctly. You can acquire a state listing from the system under test and compare it to a listing that is known to be good. If there are errors, the Difference Listing, which you will use next, shows you if there are any bad states and where they occur.

Figure 21

Press the List MENU key and choose Compare from the pop-up.

Highlight this field and press Select. Highlight Execute in the pop-up, then press Select.



Copying the State Listing to the Compare Reference

Change the Jumper

Changing the glitch jumper changes channel 7 of the counter, so that some of the acquired states will not match the original listing. After you change the jumper, you will acquire the data again in the next exercise, then compare it to the data you stored to the Reference Listing.

1 **Pull the glitch jumper from the pins labeled GLITCH OFF.**

2 **Push the jumper onto the pins labeled GLITCH ON.**

Figure 22

Run the State Analyzer and Find the Errors

1. Highlight the **Reference Listing** field, then press the **Select** key to switch to the **Difference Listing.**
2. Press the **Run** key.

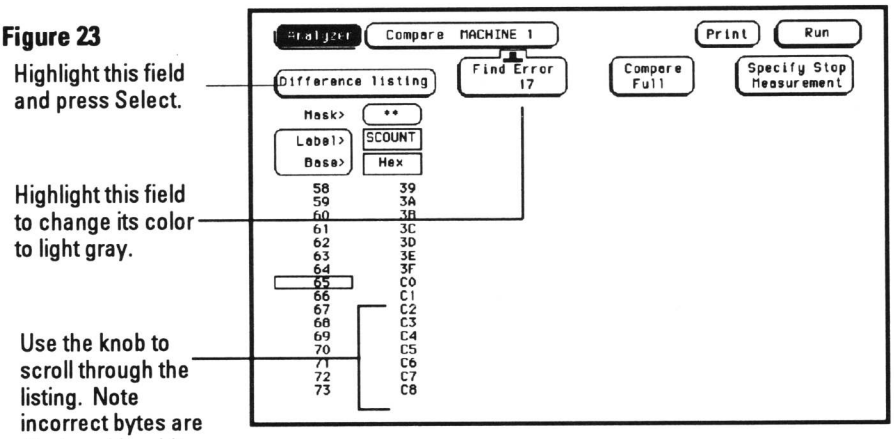
   The listing now shows the data that you just acquired. The logic analyzer compares this data to the data that you stored in the Reference Listing.
3. Highlight the **Find Error** field to change its color to light gray.
4. Use the knob to scroll through the listing and observe the states where one of the hex numbers is white.

   The white color indicates states in the new listing that do not match the reference listing. As you turn the knob, each error moves to the vertical center of the listing with its state location displayed in the line number box. The Find Error field is updated to display the corresponding error number.

   As you turn the knob, you will see that large sections of the listing that do not contain errors are skipped. Using the Find Error function makes it easier to identify the sections of the listing that do contain errors.
5. Return the Glitch Jumper on the training board to the OFF position.
6. Press the **List** MENU key. Choose **Listing MACHINE 1** from the pop-up.

   Steps 5 and 6 reset the training board and the analyzer for the next exercises.

Figure 23



Difference Listing

4

Mixed Mode Exercises

Mixed Mode Exercises

Mixed mode allows you to analyze a system in both state and timing modes, simultaneously. A common example is using the state analyzer to capture a problem that occurs infrequently and then analyzing the problem in detail with the timing analyzer. The Mixed Mode exercises will show you how to use the mixed mode capabilities of the timing and state analyzers. These exercises are built on the timing and state exercises in chapters 1 and 2.

If your logic analyzer is an HP 1663A, you will not be able to perform these exercises. The HP 1663A has 32 data acquisition channels on two pods. All 32 channels may be assigned to either state or timing analysis, but they cannot be separated to perform mixed mode measurements.

In this chapter you will learn how to:

- Connect the timing analyzer
- Enable time-correlation between the timing and state analyzers
- Arm the timing analyzer with the state analyzer
- Select the Mixed Mode display
- Run the analyzers and view time-correlated marker placement

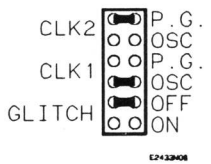
Starting the Exercises

> If your logic analyzer is an HP 1663A, you will not be able to perform these exercises. The HP 1663A has 32 data acquisition channels on two pods. All 32 channels may be assigned to either state or timing analysis, but they cannot be separated to perform mixed mode measurements.

1 Set the jumpers as shown below.

The jumper settings of J5 on the training board for this chapter are the same as the default settings.

Figure 24



2 Decide what to do next.

If you have just completed all of the exercises in chapters 1 through 3, go to "Connect the Timing Analyzer" on the next page.

If you have not just completed all of the exercises in chapters 1 through 3, go to step 2.

3 Load the configuration files CH04.__ and CH04._A.

The files will default all system settings, then set up the analyzer as if you had just completed all of the exercises in chapters 1 through 3.

If you are using an HP 1661A, HP 1662A, or HP1663A, you may see an advisory message when you load the files. This is not an error. The message is displayed because these logic analyzers have a different number of data pods from the HP 1660A, which was used to create the files.

4 Connect Pod 1.

Connect Pod 1 of the logic analyzer to J1 on the Logic Analyzer Training Board. Pod 1 is the top cable in the left-most position when you are facing the rear of the logic analyzer.

See Also

"To Set the Jumpers" and "To Load a Configuration" in chapter 6 for more information.

Connect the Timing Analyzer

> If you have a termination adapter, HP part number 01650-63203, connect the adapter between Pod 3 of the logic analyzer and J2 of the training board, then go to the next page.

1 Connect the Pod 3 connector to the probe assembly (see figure 25, below, and figure 43 on the inside back cover).

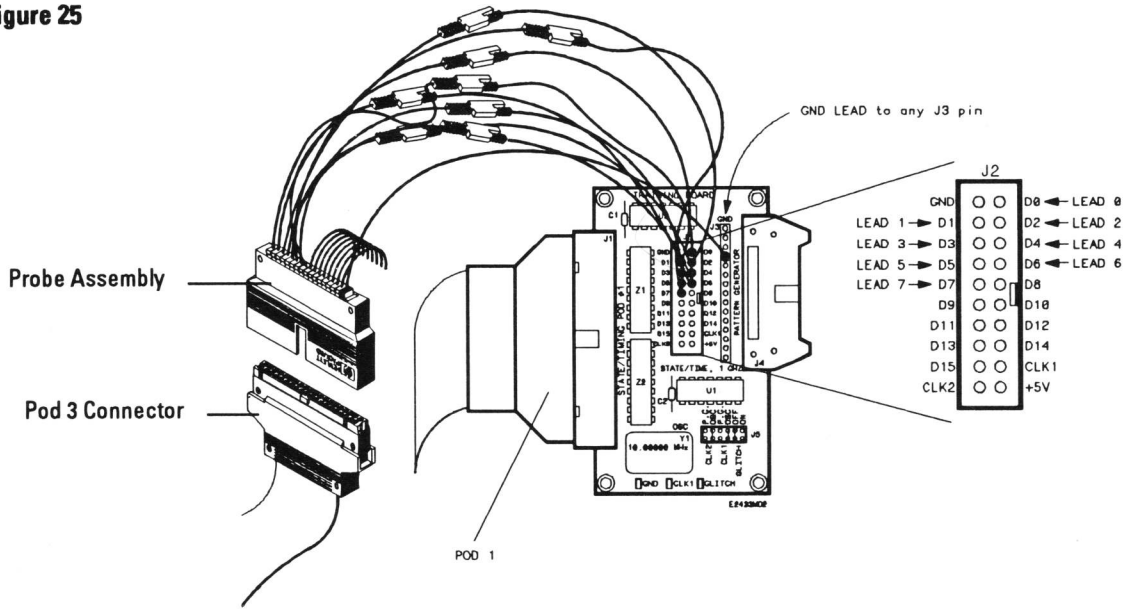
Pod 3 is the top cable in the second connector from the left, as you are facing the back of the logic analyzer.

> Leave Pod 1 connected to J1 of the training board. Pod 1 provides the +5 V power for the training board.

2 Connect the probe leads 0 through 7 to the pins D0 through D7 of J2.

3 Connect the probe ground lead to any pin of J3.

Figure 25



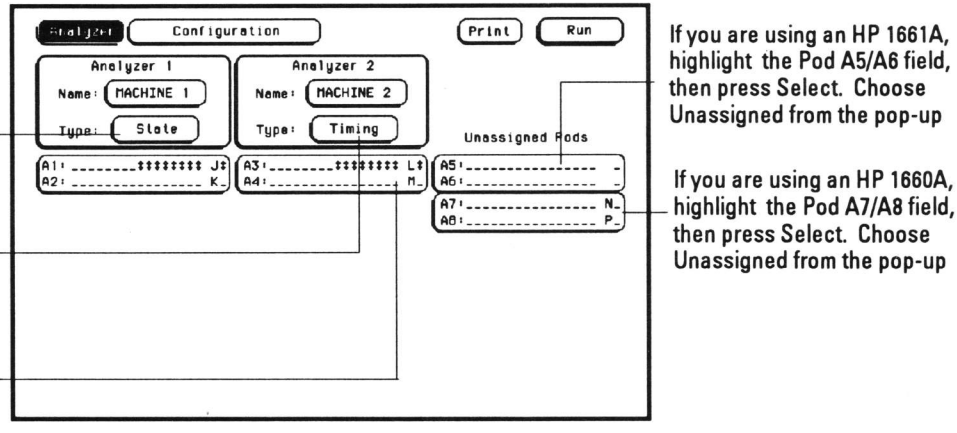
Connecting the Pod 3 Cable to the Probe Assembly

Configure the State and Timing Analyzers

1. Press the **Config** MENU key.
2. Highlight the field to the right of **Type** in the Analyzer 2 box, then press the **Select** key. Choose **Timing** from the pop-up menu.
3. Highlight the field to the right of **Type** in the Analyzer 1 box, then press the **Select** key. Choose **State** from the pop-up menu.
4. Highlight the Pod A3/A4 field, then press the **Select** key. Choose **Machine 2** from the pop-up.
5. If you are using an HP 1662A, go to the next page. If you are using an HP 1661A, highlight the Pod A5/A6 field. If you are using an HP 1660A, highlight the Pod A7/A8 field.
6. Press the **Select** key, then choose **Unassigned** from the pop-up.

   The pod pairs can be assigned to either analyzer, giving you flexibility in how you set up your measurements.

Figure 26


Configuration
Print
Run
Analyzer 1
Name: MACHINE 1
Type: State
Analyzer 2
Name: MACHINE 2
Type: Timing
Unassigned Pods
A1: ********
A2:
A3: ********
A4:
A5:
A6:
A7:
A8:
Highlight this field, then press Select. Choose State from the pop-up.
Highlight this field, then press Select. Choose Timing from the pop-up.
Highlight the Pod A3/ A4 field and press Select. Choose Machine 2 from the pop-up
If you are using an HP 1661A, highlight the Pod A5/A6 field, then press Select. Choose Unassigned from the pop-up
If you are using an HP 1660A, highlight the Pod A7/A8 field, then press Select. Choose Unassigned from the pop-up

Configuring the State and Timing Analyzers

Create a Timing Analyzer Label

1 Press the **Format** MENU key twice.
2 Choose **Format MACHINE 2** from the pop-up.
3 Highlight the top field under **Labels**, then type TCOUNT, using the keypad. Press the **Done** key when you are finished typing.
4 Highlight the field showing the 16 channels of Pod A3, to the right of the TCOUNT label. Press the **Select** key.
5 Press the ⇑ (up-arrow) key to place asterisks in the lower eight channel positions. Press the **Done** key.

The top label is now the TCOUNT label, with the lower eight channels of Pod A3 assigned to it.

Turn on the TCOUNT Label in the Waveform Menu

1 Press the **Waveform** MENU key.
2 If the channels of the TCOUNT label are listed along the left side of the display, go to "Clear the Timing Analyzer Trigger," below.
3 Highlight the large field on the left side of the display, then press the **Select** key.
4 Choose **Insert** from the pop-up menu.
5 Press the **Select** key to choose TCOUNT
6 Choose **Sequential** from the next pop-up menu.

The sequential option inserts all channels of the label into the display.

Clear the Timing Analyzer Trigger

1 Press the **Trigger** MENU key to display the Trigger MACHINE 2 menu.
2 Highlight the **Clear Trigger** field on the right side of the screen, then press the **Select** key. Choose **All** from the pop-up.

The timing analyzer must trigger as soon as it is armed by the state analyzer, so you have set the timing trigger specification to a "don't care" state.

Set Up the State Trigger Sequence

1 Press the **Trigger** MENU key. Choose **Trigger MACHINE 1** from the pop-up. The Trigger MACHINE 1 menu is now displayed. If this is not the case, press the **Trigger** MENU key again, then choose **Trigger MACHINE 1** from the pop-up.

2 Turn the knob to display the **a** term in the bottom left corner of the screen. Highlight the field to the right of **a**, below the SCOUNT label.

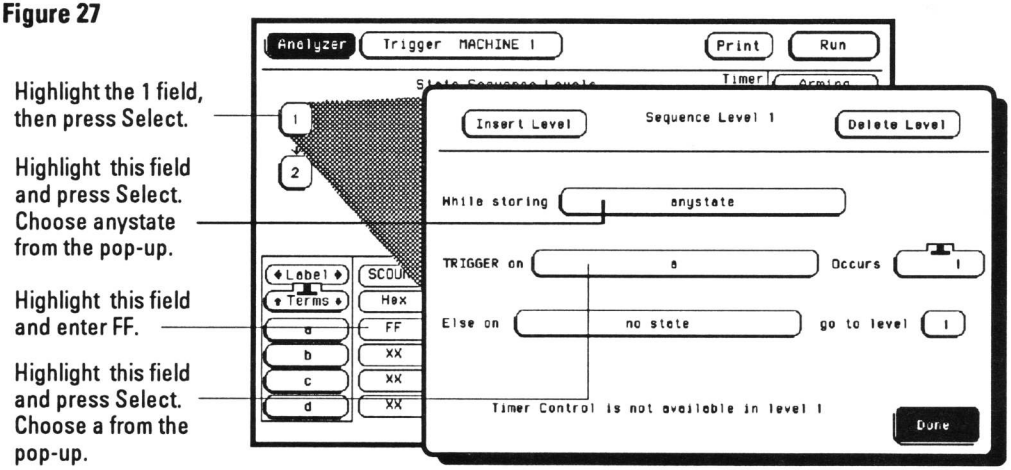
3 Enter FF using the keypad. Press the **Done** key when you are finished..

4 Highlight the **1** field, then press the **Select** key.

5 Highlight the field to the right of **While storing**, then press the **Select** key. Choose **anystate** from the pop-up.

6 Highlight the field to the right of **TRIGGER on**, then press the **Select** key. Choose **a** from the pop-up. Press the **Done** key to close the pop-up.

Figure 27



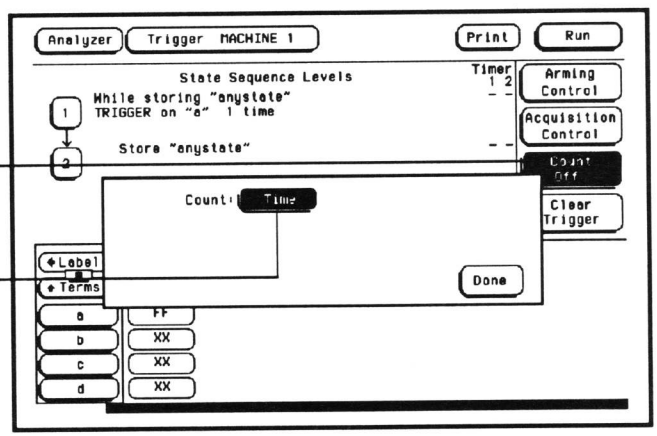
Setting Up the State Trigger Sequence

Enable Time Correlation between the Timing and State Analyzers

1. Highlight the **Count Off** field, then press the **Select** key.
2. In the pop-up, highlight the field to the right of **Count**. Press the **Select** key.
3. Choose **Time** from the next pop-up. Press the **Done** key to close the Count pop-up.

   Setting the Count to Time causes the state analyzer to store a time value, called a time stamp, for each data point that is stored in memory. When the mixed display is selected, the time stamp information is used to display the data in both the timing and state displays with the proper time relationship (correlation).

Figure 28



Enabling Time Correlation

Arm the Timing Analyzer

1 Highlight the **Arming Control** field, then press the **Select** key.

2 Highlight **MACHINE 2**, then press the **Select** key.

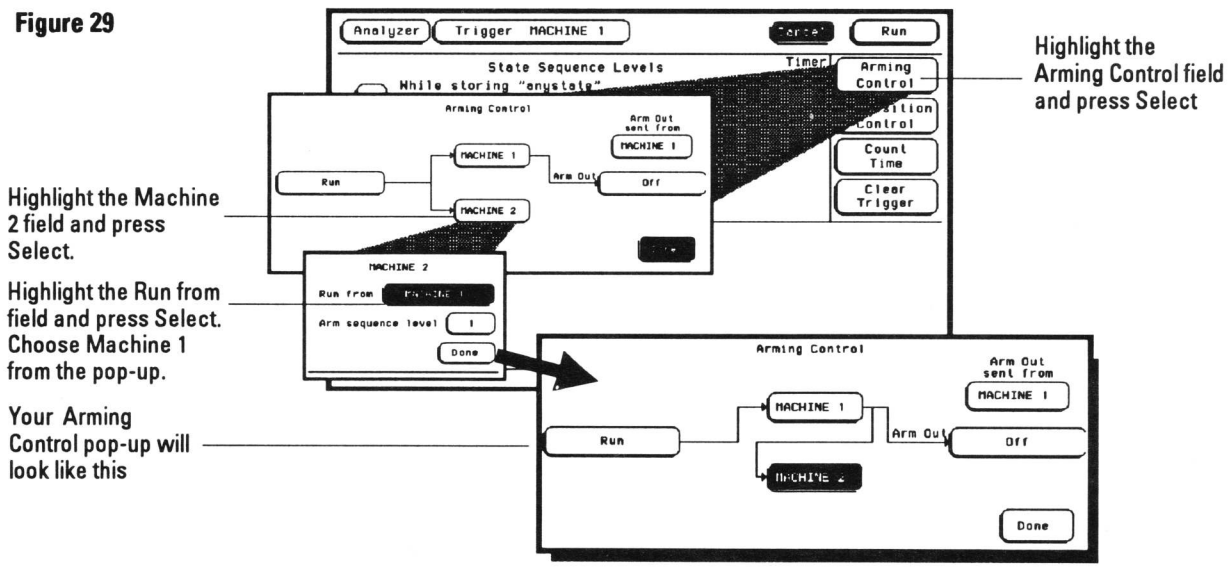
3 Highlight the field next to **Run from**, then press the **Select** key.

4 Choose **MACHINE 1** from the pop-up. Press the **Done** key. Your Arming Control pop-up should look like the one shown below.

When Machine 1 (the state analyzer) arms Machine 2 (the timing analyzer), Machine 2 waits for the state trigger condition to be met before it begins to look for its own timing trigger condition. In this way, the data stored by both analyzers can be time-correlated.

5 Press the **Done** key twice to return to the Trigger Menu.

Figure 29



Arming the Timing Analyzer

Run the Analyzers and View the Mixed Mode Display with Time-Correlated Markers

1 Press the **Run** key.

2 Press the **List** MENU key. Choose **Mixed Display** from the pop-up.

Note that the trigger points for both the timing analyzer and the state analyzer are on the same data. In the State Listing display, the trigger is FF. In the Timing Waveform display, the trigger is located on the waveform where all eight lines are high, corresponding to a hexadecimal value of FF.

There may be a slight delay between the state trigger and the timing trigger, causing the timing trigger marker to appear to the right of the FF state. This is due to the time required for the state analyzer to arm the timing analyzer.

3 Highlight the **Trig to X** field.

4 Rotate the knob and observe that the X markers move in both displays.

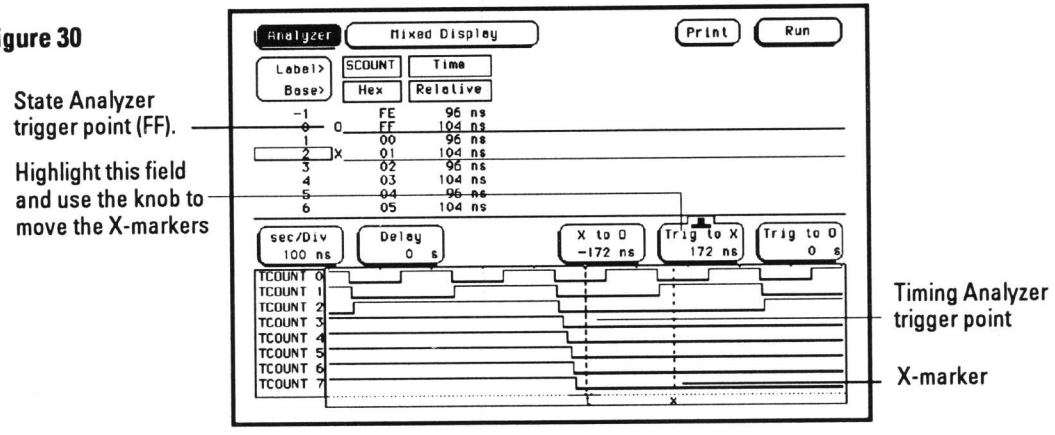
5 Press the **Trigger** MENU key twice. Choose **Trigger MACHINE 1** from the pop-up.

6 Highlight the **Count Time** field, then press the **Select** key twice. Choose **Off** from the pop-up menu.

Steps 5 and 6 turn off the Time Count function for the next exercise.

See Also Figure 28 on page 50, if you need help turning off Time Count.

Figure 30



Mixed Mode Display

5

Multilevel State Triggering

Multilevel State Triggering Exercises

The power of the state analyzer lies in its wide range of trigger capabilities. These exercises will step you through the process of using the multilevel triggering capabilities of the state analyzer, giving you a strong foundation for using its additional capabilities. You should do these exercises in the order given since they will be similar to the logical order you will perform many of your day-to-day tasks.

In this chapter you will learn how to:

- Define individual trigger terms
- Define range trigger terms
- Add state trigger sequence levels
- Set up multiple state trigger levels
- Define a combination trigger term
- Run the state analyzer and view the state listing

Starting the Exercises

1 Decide what to do next.

If you have just completed all of the exercises in Chapters 1 through 4, go to "Configure the State and Timing Analyzers" on the next page.

If you have not just completed all of the exercises in Chapters 1 through 4, go to step 2.

2 Load the configuration files CH05.__ and CH05._A.

The files default all system settings, and set up the analyzer as if you had just completed all of the exercises in Chapters 1 through 4.

If you are using an HP 1661A, HP 1662A, or HP1663A, you may see an advisory message when you load the files. This is not an error. The message is displayed because these logic analyzers have a different number of data pods from the HP 1660A, which was used to create the files.

3 Connect Pod 1.

Connect Pod 1 of the logic analyzer to J1 on the Logic Analyzer Training Board. Pod 1 is the top cable in the left-most position when you are facing the rear of the logic analyzer.

4 Set the jumpers as shown below.

The jumper settings of J5 on the training board for this chapter are the same as the default settings.

Figure 31

See also

"To Set the Jumpers" in chapter 6 for more information about setting the jumpers.

"To Load a Configuration" in chapter 6 for instructions to load the configuration files.

Configure the State and Timing Analyzers

1 Press the **Config** MENU key.
2 Highlight the field to the right of **Type** in the Analyzer 2 box, then press the **Select** key. Choose **Off** from the pop-up.
3 Highlight the field to the right of **Type** in the Analyzer 1 box then press the **Select** key. Choose **State** from the pop-up.

Set Up the State Analyzer Format

1 Press the **Format** MENU key.
2 Highlight the second field from the top, below **Labels**, then press the **Select** key. Choose **Turn Label On** from the pop-up.
The label SCOUNT should now be active, with the lower eight channels of Pod 1 assigned to it. If this is not the case, perform the steps in "Change a State Label Name" on page 24 and"Modify the State Analyzer Channel Assignments" on page 25.

Starting the Exercises

1 Decide what to do next.

If you have just completed all of the exercises in Chapters 1 through 4, go to "Configure the State and Timing Analyzers" on the next page.

If you have not just completed all of the exercises in Chapters 1 through 4, go to step 2.

2 Load the configuration files CH05.__ and CH05._A.

The files default all system settings, and set up the analyzer as if you had just completed all of the exercises in Chapters 1 through 4.

If you are using an HP 1661A, HP 1662A, or HP1663A, you may see an advisory message when you load the files. This is not an error. The message is displayed because these logic analyzers have a different number of data pods from the HP 1660A, which was used to create the files.

3 Connect Pod 1.

Connect Pod 1 of the logic analyzer to J1 on the Logic Analyzer Training Board. Pod 1 is the top cable in the left-most position when you are facing the rear of the logic analyzer.

4 Set the jumpers as shown below.

The jumper settings of J5 on the training board for this chapter are the same as the default settings.

Figure 31

See also

"To Set the Jumpers" in chapter 6 for more information about setting the jumpers.

"To Load a Configuration" in chapter 6 for instructions to load the configuration files.

Define State Trigger Terms "a" through "d"

In these exercises, you will set up the analyzer to check for a complex sequence of states before it triggers. While the analyzer checks for these states, it will store only selected states that you define. As in chapter 2, you will define your trigger terms first, then use these terms to define a sequence of events. In this case, the sequence will be made up of states of the ripple counter on the training board. You can use this same method to monitor any state sequence, such as subroutine calls or read and write cycles of a microprocessor.

1 Press the **Trigger** MENU key.

2 Highlight the base field to the right of **Terms**, below the SCOUNT label, then press the **Select** key. Choose **Decimal** from the pop-up menu.

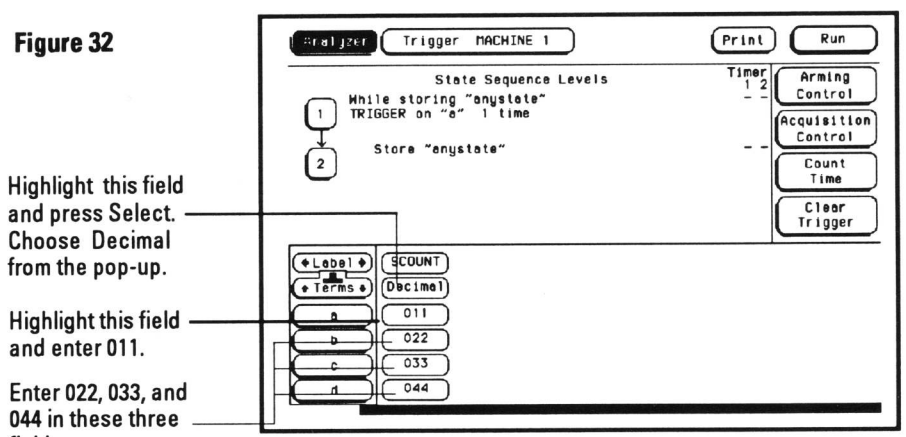
You may notice dollar signs ($) in the fields below the SCOUNT label when you select decimal. The dollar signs appear when the resolution, or width, of the field does not match the base you have selected. Once you enter the data and close the pop-up, the field will display the correct data.

3 Highlight the field to the right of **a** below the SCOUNT label.

4 Enter 011 using the keypad. Press the **Done** key when you are finished typing.

5 Repeat steps 3 and 4 to enter 022, 033, and 044 in terms **b**, **c**, and **d**, respectively.

Figure 32



Defining State Trigger Terms "a" through "d"

Define State Trigger Terms "e" and Range1

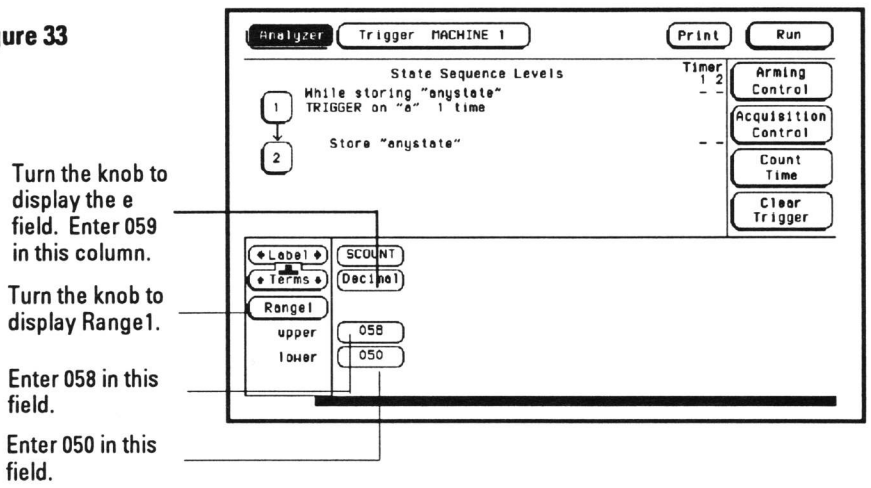
1 Turn the knob clockwise to display the **e** term in the bottom left corner of the display. Highlight the field to the right of **e**, below the SCOUNT label. Enter 059 using the keypad. Press the **Done** key.

2 Turn the knob until the Range1 term is displayed. Highlight the field to the right of **upper**, below SCOUNT. Enter 058 using the keypad. Press the **Done** key.

3 Highlight the field to the right of **lower**, below SCOUNT. Enter 050, using the keypad. Press the **Done** key.

In addition to terms "a" through "e," the HP 1660 series logic analyzers provide another five terms, "f" through "j," for a total of ten pattern terms. The state analyzer also provides two range terms, in which you define lower and upper limits, and two timer terms, which you can use to define durations.

Figure 33



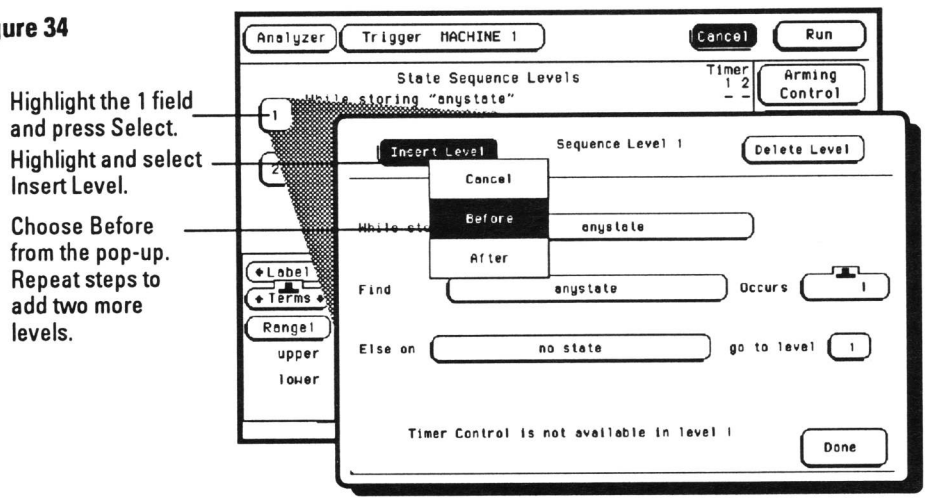
Defining State Trigger Terms "e" and Range1

Add State Sequence Levels

1. Highlight the **1** field in the State Sequence Levels box, then press the **Select** key. The Sequence Level 1 pop-up appears.
2. Highlight the **Insert Level** field, then press the **Select** key. Choose **Before** from the pop-up.
3. Repeat step 2 two more times. After inserting these two levels, press the **Done** key to close the Sequence Level 1 pop-up.

   You now see Sequence Levels 1 through 3. Notice that the text in the second line of each level changes from "Trigger on" to "Find" or "Then find."

Figure 34

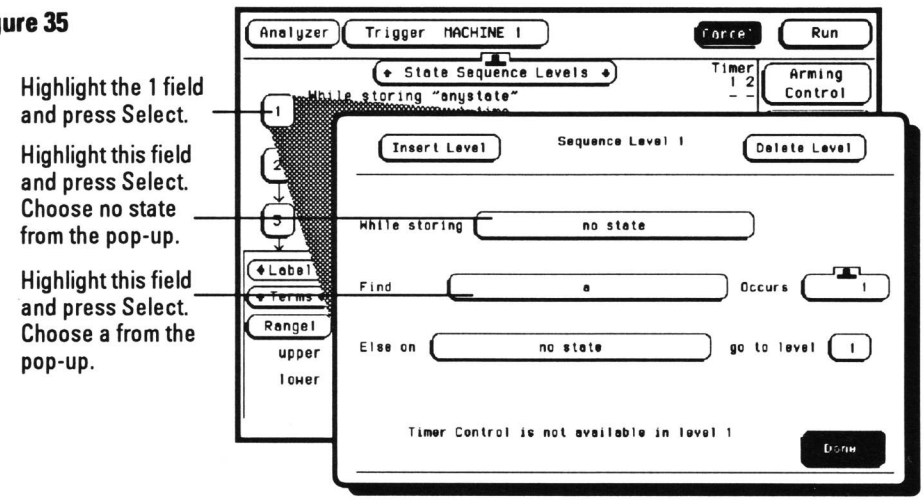


Adding State Sequence Levels

Configure State Sequence Level 1

1. Highlight the **1** field, then press the **Select** key.
2. In the pop-up, highlight the field to the right of **While storing**. Press the **Select** key. Choose **no state** from the pop-up menu.
3. Highlight the field to the right of **Find**, then press the **Select** key. Choose **a** from the pop-up menu.
4. Press the **Done** key to close the Sequence Level 1 pop-up.

Figure 35

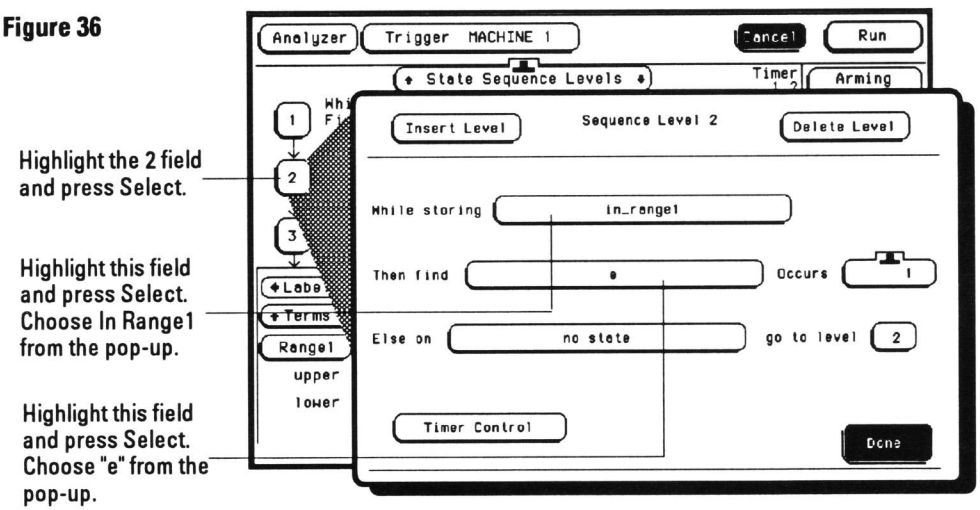


Configuring State Sequence Level 1

Configure State Sequence Level 2

1. Highlight the **2** field, then press the **Select** key.
2. In the pop-up, highlight the field to the right of **While storing**, then press the **Select** key. Choose **In range1** from the pop-up menu.
3. Highlight the field to the right of **Then find**, then press the **Select** key. Choose **e** from the pop-up menu.
4. Press the **Done** key to close the Sequence Level 2 pop-up.

Figure 36



Configuring State Sequence Level 2

Configure State Sequence Level 3

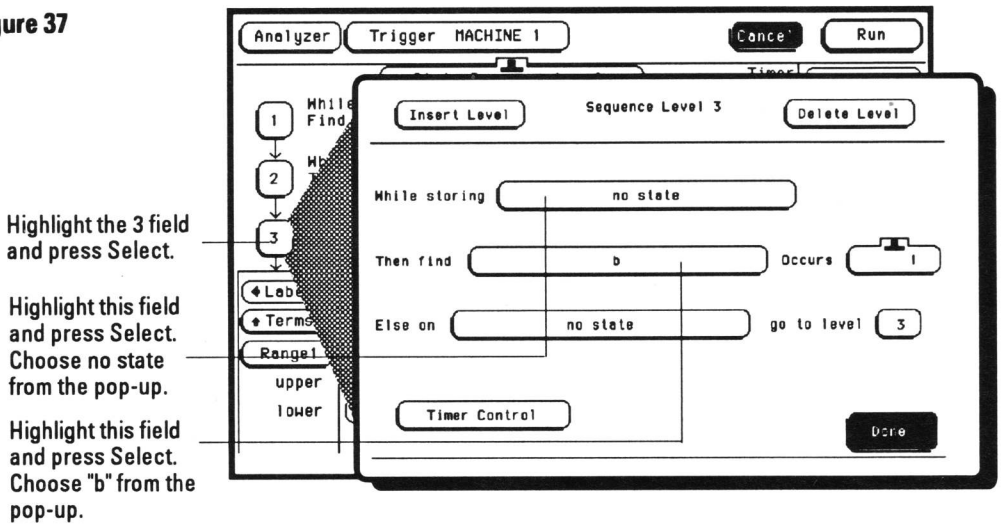
1 Highlight the **3** field in the State Sequence Levels box, then press the **Select** key.

2 Highlight the field to the right of **While storing**, then press the **Select** key. Choose **no state** from the pop-up menu.

3 Highlight the field to the right of **Then find**, then press the **Select** key. Choose **b** from the pop-up menu.

4 Press the **Done** key to close the Sequence Level 3 pop-up.

Figure 37



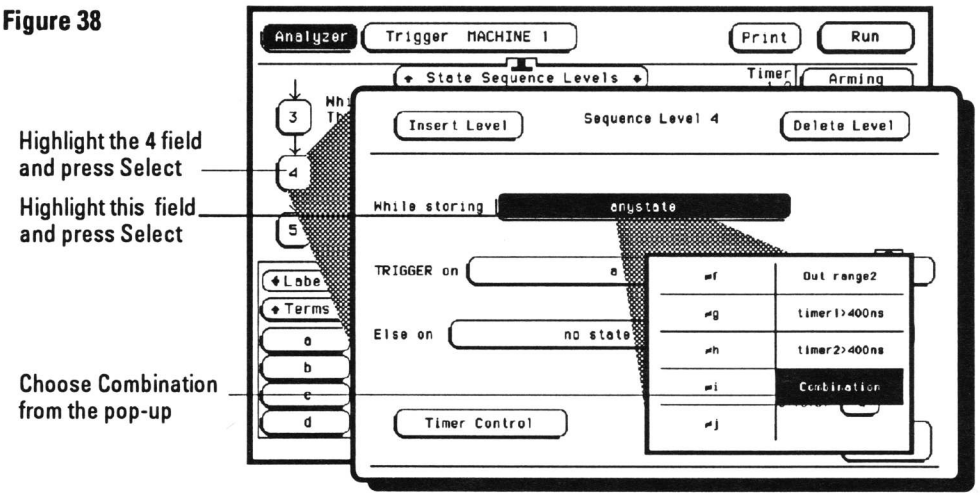
Configuring State Sequence Level 3

Configure State Sequence Level 4

1. Turn the knob clockwise to display sequence levels 3, 4, and 5.
2. Highlight the **4** field, then press the **Select** key. Highlight the field to the right of **While storing**, then press the **Select** key.
3. Choose **Combination** from the pop-up menu.

   Another pop-up appears, showing you a graphical menu in which you can define Boolean combinations of your trigger terms. You will define a combination of ("c" OR "in_range1" OR "d") in the next exercise.

Figure 38



Configuring State Sequence Level 4

Define a Combination Term

1. In the combination pop-up menu, highlight the **c** field, then press the **Select** key. Choose **ON** from the pop-up menu.

   The "c" term is now turned on and the display shows a connection from "c" to one of the Or fields. The Or field represents the Or Boolean function.

2. Highlight the **in_range1** field, then press the **Select** key. Choose **In** from the pop-up.

   When you select "In", the logic analyzer looks for values that are within the limits for the term Range1. You defined the limits in the "Define State Trigger Term 'e' and Range1" exercise.

3. Highlight the **d** field, then press the **Select** key. Choose **ON** from the pop-up.

   Note the "Current Qualifier" display in the top right corner of the screen. Your qualifier is now "c + in_range1 + d."

4. Press the **Done** key once to close the Combination Term pop-up.

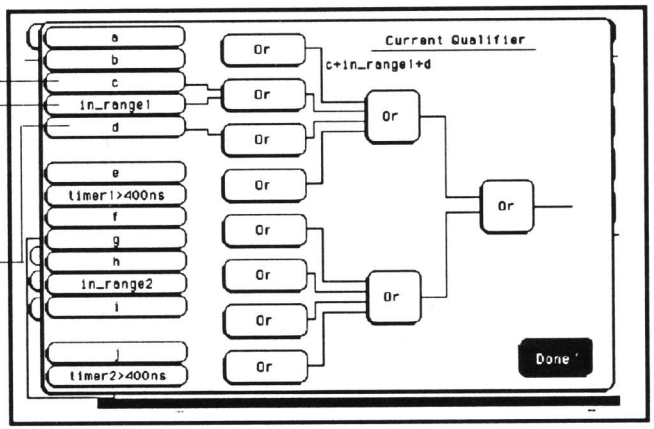
   The "While storing" term in Sequence Level 4 is replaced by the Boolean expression, "c + in_range1 + d."

Figure 39

Highlight and select c, then choose On from the pop-up

Highlight and select in_range1, then choose In

Highlight and select d, then choose On



Defining a Combination Term

Define the Trigger Term and Check the Trigger Specification

1 Highlight the field to the right of the **TRIGGER on** field, then press the **Select** key. Choose **e** from the pop-up menu.

2 Press the **Done** key to close the Sequence Level 4 pop-up.

3 Using the knob, scroll through the sequence levels to confirm the following Trigger Specification:

- Level 1 - While storing "no state"; Find "a" one time
- Level 2 - While storing "in_range1"; Then find "e" one time
- Level 3 - While storing "no state"; Then find "b" one time
- Level 4 - While storing "c + in_range1 + d" ; TRIGGER on "e" one time
- Level 5 - Store "any state"

If your trigger specification is not correct, repeat the appropriate exercises on the previous pages, to correct the sequence levels that do not match.

Run the State Analyzer and View the Trace

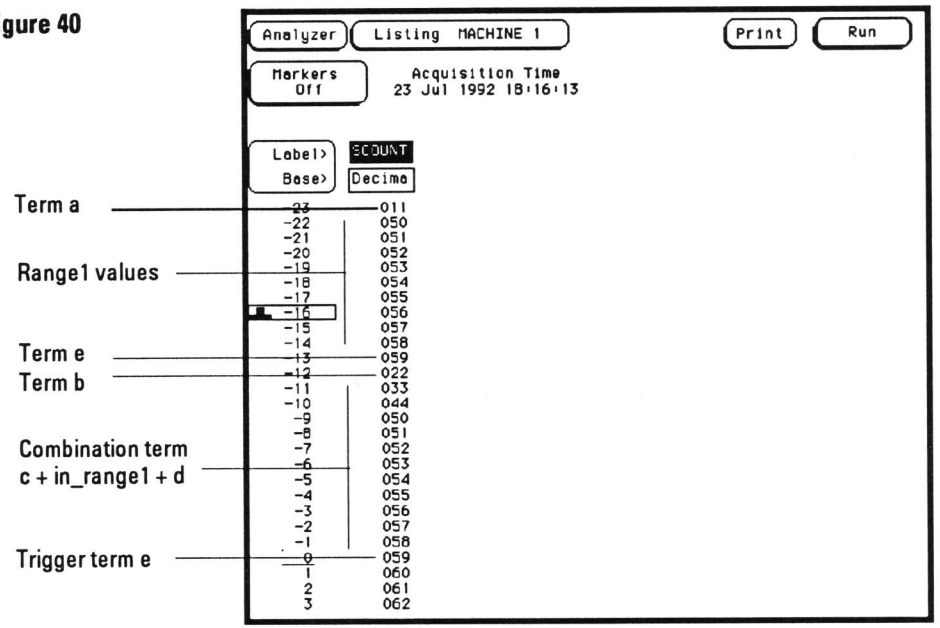
1 Press the **Run** key.

2 Highlight the base field below the SCOUNT label, then press the **Select** key. Choose **Decimal** from the pop-up.

3 Highlight the line number field on the left side of the display. Scroll the listing to the beginning by turning the knob counter-clockwise.

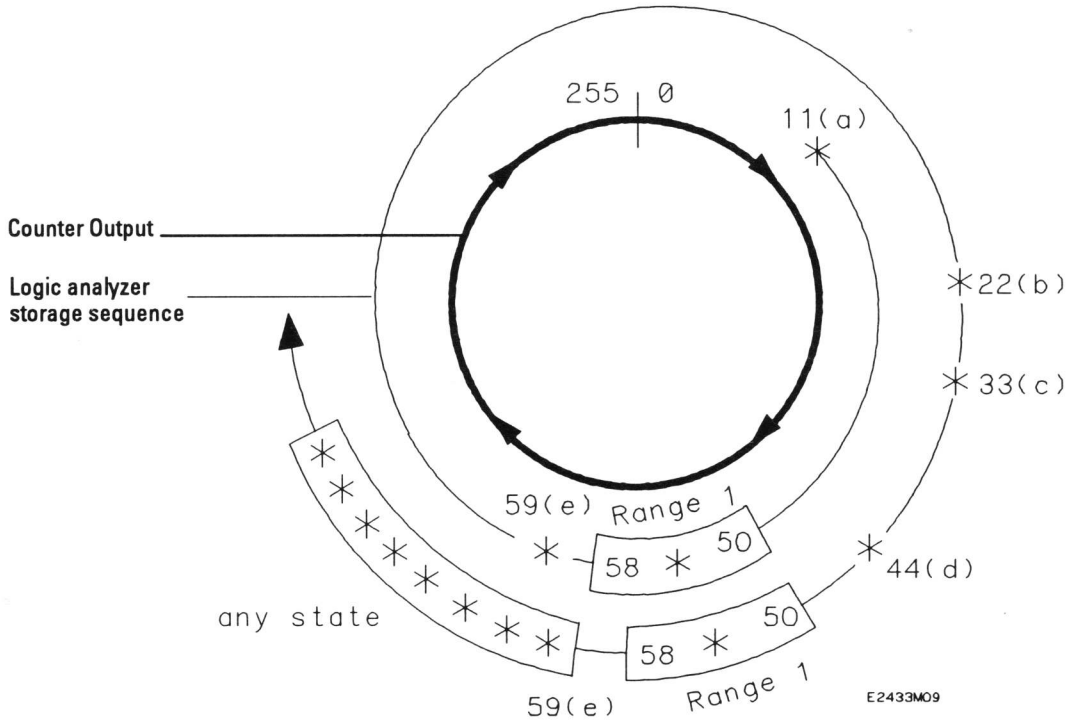
Your listing now matches the data under the SCOUNT label in the listing in figure below. The first state in your listing is decimal 011 which is term "a." You then see the Range1 values (050 - 058), followed by terms "e," "b," and the combination term "c + in_range1 + d". At line number 0, you see the trigger term "e," followed by "anystate".

Figure 40



State Listing

Figure 41



Ripple Counter Output and Stored States

Figure 41, above, shows you the output of the ripple counter (the circle) and the sequence of qualification and storage that the state analyzer performed. The asterisks indicate when the state analyzer found and stored valid terms in this example. All states were initially excluded, using the "no state" term. Next, states that were within the specified Range1 term (50 - 58) were stored, while the analyzer searched for an occurrence of term "e." Once the remaining terms and range were found in the specified sequence, the state analyzer stored everything (anystate) until its acquisition memory was filled.

With multilevel state triggering, you specify the data to be stored by the state analyzer. If you are debugging software, you can store or exclude certain program lines or entire blocks of code, such as subroutines

Part 2

6 Setting the Jumpers and Loading the Configurations 71

7 All About the Logic Analyzer Training Board 77

Logic Analyzer Training Board Reference

6

Setting the Jumpers and Loading the Configurations

Setting the Jumpers and Loading the Configurations

Setting the Jumpers

The jumpers on J5 of the training board are used to control the source of the state clock and to turn the glitch on or off. Before you start each chapter, you should check the jumpers to make sure they are properly set. The "To Set the Jumpers" exercise, on the next page, gives you the information you need to change the jumpers. Table 1 shows you the jumper settings for each chapter at a glance.

Table 1 **Jumper Settings**

		Jumper	
	Glitch	**CLK1**	**CLK2**
Default	OFF	OSC	P.G. (pattern generator)
Chapter 3 (change during exercises)	ON	OSC	P.G.

To Set the Jumpers

1 Pull the appropriate jumper off of the pins of J5.

2 Push the jumper onto the correct pins of J5 (see figure 43, inside the rear cover). You only need to change jumpers that differ from the settings in table 1.

Set the jumpers at their default settings for all chapters. Table 1 shows you the default settings and the settings for each chapter. Chapter 3, "State Compare Exercises," requires you to change the setting of the glitch jumper part way through the exercises.

Loading the Configurations

If you are not performing the exercises in order, you may need to load configuration files to set up your system so that you can complete the exercises. The "To Load a Configuration File" exercise on the next two pages gives you the information you need to load configuration files. The flexible disk labeled "Logic Analyzer Training Kit Configurations," which you received in this training kit, contains the configuration files. The files are listed in Table 2, below.

If you are doing the exercises for the first time, we recommend you follow the steps in each consecutive exercise, from Chapter 1 through Chapter 5, without loading the configuration files. If you do not want to do the exercises in order, you can load the files listed in the "Starting the Exercises" section of a chapter, then do the exercises in that chapter.

There are also two sample application files on the flexible disk, called "MOTOROLA" and "I80960." These files allow you to view sample advanced configurations and data, acquired by an HP 1660-Series Logic Analyzer. If you are using an HP 1660A or an HP 1661A, you can load these files by following the steps on the next two pages.

Table 2 **Configuration Files**

Filename	File description
CH02 and CH02._A	State Exercises
CH03 and CH03._A	Compare Exercises
CH04 and CH04._A	Mixed Mode Exercises
CH05 and CH05._A	Multi-level State Triggering Ex.
I80960	i80960 Waveform/Symbols
MOTOROLA	68332 Disassembled Data

To Load a Configuration File

1 Place the flexible disk labeled "LOGIC ANALYZER TRAINING KIT CONFIGURATIONS" in the disk drive.

2 Press the **System** MENU key.

3 The Disk Menu is now displayed. If this is not the case, press the **System** MENU key and choose **Disk** from the pop-up.

If the file directory has not been previously read by the logic analyzer, you will see "reading directory . . ." before the directory listing is displayed.

4 Highlight the field below the **System** field, on the left side of the screen, then press the **Select** key. Highlight **Load** in the pop-up menu, then press the **Done** key.

See figure 42 on the next page if you need help.

5 Highlight the field to the right of **Load**, then press the **Select** key. Highlight **All** in the pop-up menu, then press the **Done** key.

The All option sets up the analyzer to load all files with a given file name. This allows you to load files CH0x.__ and CH0x._A at the same time.

The procedure for loading a configuration file continues on the next page.

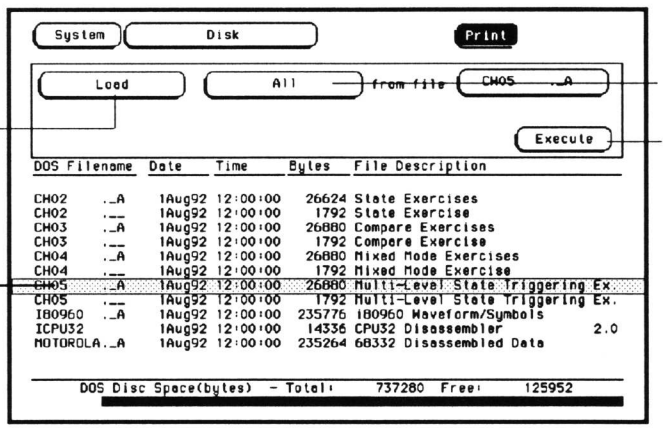
6 Using the knob, place the file name you want to load on the light gray center line of the display.

7 Highlight the **Execute** field, then press the **Select** key. Highlight the **Continue** in the pop-up, then press the **Select** key

If you are using a logic analyzer model other than an HP 1660A, a message may appear, telling you that some pod information has been changed or truncated. This is not an error. The message appears because your logic analyzer has fewer data pods than an HP 1660A, which was used to create the file you are loading.

8 Repeat steps 6 and 7 for any other files you want to load, or press one of the MENU keys to return to a logic analyzer control menu.

Figure 42


System
Disk
Print
Load
All
from file
CH05 .A
Execute
DOS Filename Date Time Bytes File Description
CH02 .A 1Aug92 12:00:00 26624 State Exercises
CH02 .__ 1Aug92 12:00:00 1792 State Exercise
CH03 .A 1Aug92 12:00:00 26880 Compare Exercises
CH03 .__ 1Aug92 12:00:00 1792 Compare Exercise
CH04 .A 1Aug92 12:00:00 26880 Mixed Mode Exercises
CH04 .__ 1Aug92 12:00:00 1792 Mixed Mode Exercise
CH05 .A 1Aug92 12:00:00 26880 Multi-Level State Triggering Ex.
CH05 .__ 1Aug92 12:00:00 1792 Multi-Level State Triggering Ex.
IB0960 .A 1Aug92 12:00:00 235776 IB0960 Waveform/Symbols
ICPU32 1Aug92 12:00:00 14336 CPU32 Disassembler 2.0
MOTOROLA.A 1Aug92 12:00:00 235264 68332 Disassembled Data
DOS Disc Space(bytes) - Total: 737280 Free: 125952

Highlight this field and press Select. Choose Load from the pop-up.

Use the knob to place the name of the file you want to load on this line.

Highlight this field and press Select. Choose All from the pop-up.

Highlight this field and press the Select key.

Loading a Configuration File

7

All About the Logic Analyzer Training Board

All About the Logic Analyzer Training Board

The training board helps you learn the basics of HP Logic Analyzers. The following reference information is provided for those of you who want to know more about how the training board works.

Theory of Operation

Power Source

The training board is powered by the +5 V supplied by the logic analyzer pods, so a logic analyzer pod must be connected to either J1 or J2 of the training board in order for the training board to work. If only J2 is connected, it must be connected to the logic analyzer through a termination adapter (HP part number 01650-63203).

CAUTION

If the termination adaptor part number is HP 01650-63201 , the CLK2 jumper must be set to P.G. to avoid connecting the output of the oscillator to +5 V and eventually damaging the oscillator.

If J1 is connected, the termination adaptor is not required because J1 is terminated on the board by Z1 and Z2.

Circuit Description

The training board uses an 8-bit ripple counter running at 10 MHz to produce transitions on the lower 8 bits of a logic analyzer pod. The upper eight bits can be connected to the pattern generator through connector J4.

For state analysis, you can clock the state analyzer via the oscillator on the training board (reference designator Y1) or via a pattern generator in an HP 16500 system. The sources for clocks 1 and 2 are selected by the positions of jumpers CLK1 and CLK2, respectively. When the CLK1 and CLK2 jumpers are set to OSC (oscillator), the clock source for the state analyzer is the oscillator on the training board (Y1). When the CLK1 and CLK2 jumpers are set to P.G. (pattern generator), the clock source for the state analyzer is bit D7 or strobe 2 of the pattern generator, depending on which pattern generator pod is connected to J4.

The glitch is generated using the delay between the falling edge of D4 and rising edge of D5 of the ripple counter. The counter is a 74HC393, which

produces a delay of about 6 ns between the rising and falling edges. A 74F02 is used to generate the pulse (glitch) and combine it with D7 of the ripple counter. Because the 74F02 is a fast CMOS gate, it boosts the amplitude of the glitch it receives from the 74HC393 counter. This combination of logic families produces a positive glitch that is about 6 ns wide and has an amplitude of about 4 volts. The glitch is available on channel D7 of J1 and J2 when the GLITCH jumper is set to ON.

Jumpers

The jumpers are used to turn the glitch on and off and to select the sources for state clocks 1 (CLK1) and 2 (CLK2).

Glitch

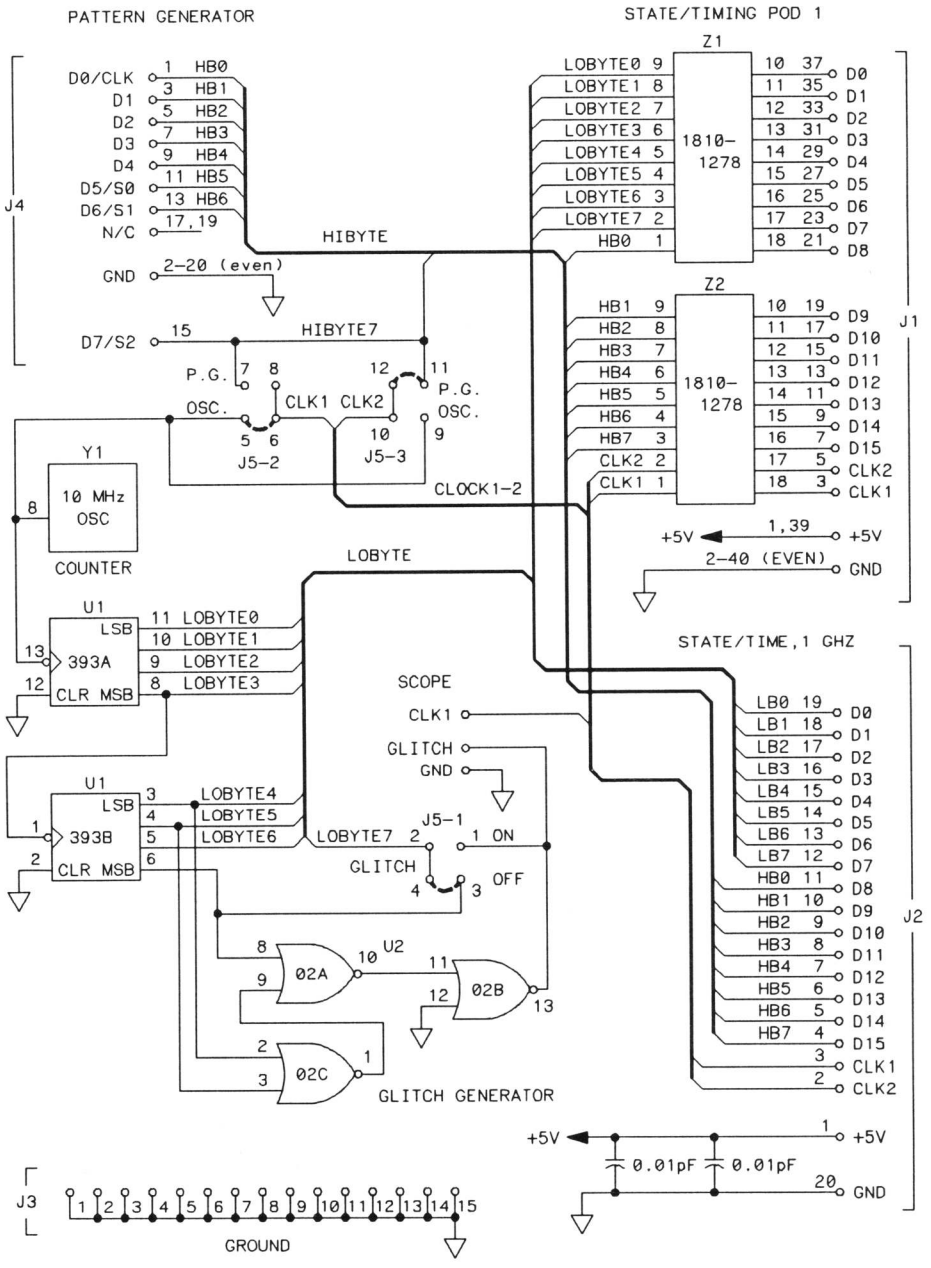
When the GLITCH jumper is set to OFF, the waveform on D7 of J1 and J2 is the most significant bit of the counter. When this jumper is set to ON, a glitch appears on D7 and the waveform no longer represents the most significant bit of the counter. The glitch always appears on the test point labeled GLITCH, regardless of the position of this jumper.

CLK1

The CLK1 jumper selects the source of state clock 1. If you choose OSC (the default), the source of the clock will be the oscillator on the training board. If you choose P.G., the source of the clock will be Strobe 2 or D7 of the pattern generator, depending on which pattern generator pod you have connected to the training board.

CLK2

The CLK2 jumper selects the source of state clock 2 for the HP 16540A. If you choose OSC, the source of the clock will be the oscillator on the training board. If you choose P.G. (the default), the source of the clock will be Strobe 2 or D7 of the pattern generator, depending on which pattern generator pod you have connected to the training board.



Logic Analyzer Training Board Schematic

Index

A
a thru j fields,16, 26
activity indicators,22
adding sequence levels,59
analysis
  state,20
  timing,12
arming control,51
arming the timing analyzer,51
arrow keys,2, 14
arrows
  setting the state clock edge,23
  showing activity in the pods,22
assigning channels
  in the state analyzer,25
  in the timing analyzer,15
  See also modifying channels
asterisk
  in channel assignments,15

B
backspace,14
base,26
Boolean,63
  or function,64

C
channel assignments
  modifying,15
channels
  assigning,15
  grouping,15
circuit description,79
Clear Entry key,15
CLK1,79
CLK2,79
clock
  edge,23
  J through P,23
  sample,20
  source,79
  state,20
  state, set the,23
Clock field
  setting the state clock,23
combination term,63–64
compare errors,41
compare image
  See also reference listing
compare state listings,34
configuration
  disk,3
  files,3
  loading,74
configuration file
  to load a,75–76
configuring
  state analyzer,22, 36
count
  time,50
counter,79
  ripple,14, 79
creating symbols,30–31
current qualifier,64

D
"don't care",48
dashes
  See activity indicators
delay,18
difference listing,39, 41
disk menu,75
dollar sign ($),57
Done key,3
down arrow,23

E
equipment list
  See materials needed
errors
  compare,41
  Find Error field,41
exercises
  mixed mode,44
  multilevel state triggering,54
  state analyzer,20
  state compare,34
  timing analyzer,12

G
glitch
  generator,79
  jumper,80

I
indicators
  activity,22

J
J-clock,22–23
jumpers,80
  CLK1,80
  CLK2,80
  default settings,72
  glitch,80
  setting,72–73

K
knob
  function of,3, 18

L
label name
  changing,14
  state,24
labels,14
listing
  difference,34, 41
  reference,39
loading the configurations,74
logic high,12, 20, 22
logic high indicator,22
logic low,12, 20, 22
logic low indicator,22

M
marker placement
  time-correlated,52
markers,18, 52
materials needed,2
menu
  pop-up,3
MENU keys,3
mixed display,52
mixed mode,44
mixed mode exercises,44
mouse,3
multilevel state triggering,54

P
page keys,29
pattern
  duration,17
  state trigger,26
  timing trigger,16
pod pair,47

pods,23, 47
pop-up menu,3
power source,79
probe leads,46
problems
  See unexpected results

R
range term,58
reference listing,39
ripple counter output,67
run,18, 29
running the state analyzer,29
running the timing analyzer,18

S
"store any state",28
s/Div field,18
sample clock,20
schematic,81
scrolling
  state listing,29
  timing waveform,18
Select key,2
Sequence Level 1 pop-up
  setting up state trigger,27
sequence levels,27–28
  adding,59
  configuring,60–62
setting the jumpers,72
state analysis,20
state analyzer,20
  running,29
state analyzer exercises,20
state compare exercises,34
state listing
  viewing and changing,29
state trigger terms
  defining,57
storage qualification,20, 67
stored states,67
symbols,30, 32
  creating,30–31
  viewing,32

T
term
  combination,63
  pattern,16, 26
  range,58
  trigger,16, 65
termination adapter,2, 46, 79
theory of operation,79
threshold,12
time
  count,50
  stamp,50
time-correlated marker placement,52
time-correlation,50
timing
  analysis,12
timing analyzer exercises,12
Trig to X field,18
trigger
  state,26–28
  timing,16–17
  to set pattern,16
trigger specification
  state,27–28
trigger term
  defining,65
  range,58

U
unexpected results,3
user's interface,2

W
"While storing no state",37
waveform
  scrolling,18
  zooming,18

Z
zooming
  timing waveform,18

About this edition

This is the first edition of the HP E2433-90910 Training Guide for the HP E2433-60004 Training Kit for HP 1660 Series Logic Analyzers. Edition dates are as follows:

1st edition, August, 1992

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by you. The dates on the title page change only when a new edition is published.

Many product updates and fixes do not require manual changes; and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

The following list of pages gives the date of the current edition and of any changed pages to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. If an update is incorporated when a new edition of the manual is printed, the change dates are removed from the bottom of the pages and the new edition date is listed on the title page.

August, 1992: All pages original edition

HEWLETT PACKARD

Ready, Set, Run: Easy Steps to Logic Analysis with the HP 1660 Series

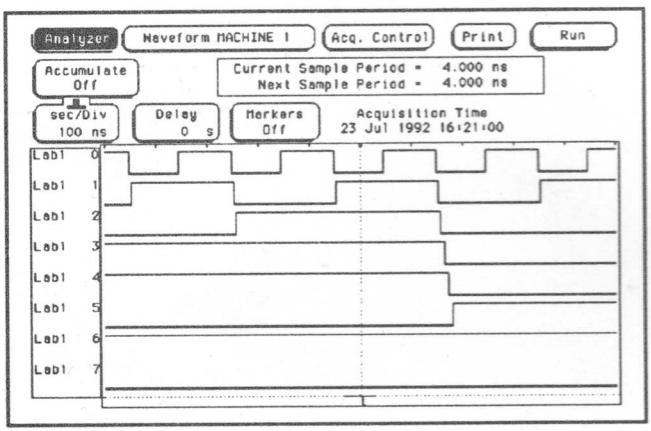
Start Here

READY Connect Pod 1 of the HP 1660-series logic analyzer to connector J1 of the Logic Analyzer Training Board. Pod 1 is the top cable in the left-most connector, when you are facing the rear of the logic analyzer.

SET Turn on the logic analyzer by pressing the power switch, near the bottom of the front panel.

The analyzer will take about 15 seconds to boot up.

RUN Press the **Run** key, near the upper right corner of the front panel. You will see the output of an 8-bit ripple counter like this:



Next

Please read the short introduction before doing the examples. This guide contains many examples of how easy the HP 1660 Series of logic analyzers is to use.

Timing Analyzer Exercises
State Analyzer Exercises
State Compare Exercises
Mixed Mode Exercises
Multi-Level State Triggering
Setting Jumpers/ Loading Configs
All About theTraining Board
Index

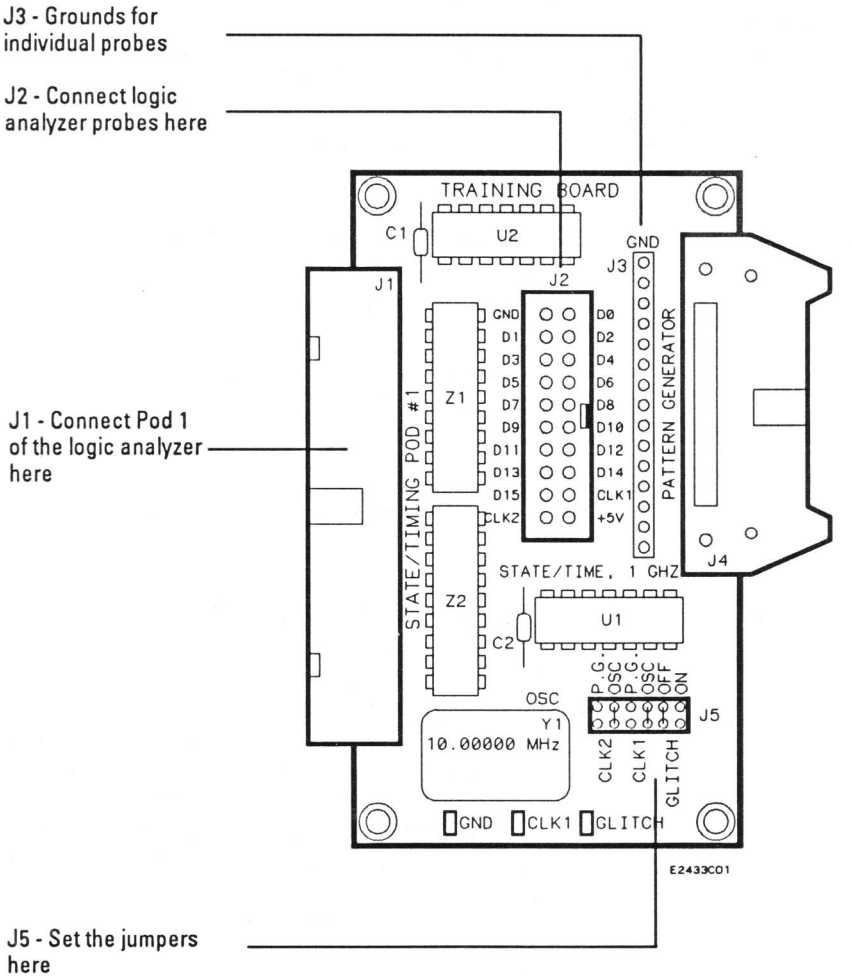



Figure 43